EXHIBIT 1

PRELIMINARY ASSESSMENT REPORT
CHAMBERS WORKS COMPLEX

Date: December 2006

Project No.: 507701
18984835

CORPORATE REMEDIATION GROUP
An Alliance between
DuPont and URS Diamond

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ACRONYM LIST

Acronym	Explanation
ACO	Administrative Consent Order
ACOE	U.S. Army Corps of Engineers
AEC	Atomic Energy Commission
AOC	Area of concern
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
BEE	Baseline Ecological Evaluation
CEAs	Classification Exception Areas
CCLP	Chambers Cogeneration Limited Partnership
CD	Chlorobutadiene
CMC	Carboxy methyl cellulose
COC	Constituent of concern
COPECs	Constituents of potential ecological concern
CRG	DuPont Corporate Remediation Group
CSM	Conceptual Site Model
DCB	1,2-dichlorobenzene
DERS	DuPont Environmental Remediation Services
DMA	Dimethylaniline
DGW	Discharge to groundwater
DNAPL	Dense nonaqueous-phase liquid
DOE	Department of Energy
DPCC	Discharge Prevention Containment and Countermeasures
EDD	Electronic Data Deliverable
EHL	Explosion Hazards Laboratory
EPA	U.S. Environmental Protection Agency
FA	Focus Area
FUSRAP	Formerly Utilized Sites Remedial Action Program
GIS	Geographical information system
GWIIA	New Jersey Class IIA groundwater criteria
HPWDS	Historical Process Water Ditch System
HSWA	Hazardous and Solid Waste
IGW	Impact to Groundwater
IRM	Interim Remedial Measure
ISM	Interim Stabilization Measure
ITRC	Interstate Technology and Regulatory Council
IWS	Interceptor Well System
LNAPL	Light nonaqueous-phase liquid
MED	Manhattan Engineer District
MFAC	Motor fuel antiknock compound
MVA	Monovinylacetylene
NAPL	Nonaqueous-phase liquid
NCB	Nitrochlorobenzene
NJDEP	New Jersey Department of Environmental Protection
NRC	U.S. National Research Council
NRDCSCC	Non-residential Direct Contact Soil Cleanup Criteria

Acronym	Explanation
NT	Nitrotoluene
o-CNB	ortho-chloronitrobenzene
ODCB	ortho-dichlorobenzene
Orechem	DuPont Organic Chemical Department
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Perchlorethylene
PCOC	Potential constituent of concern
PNBA	p-nitrobenzoic acid
PPE	Personal protective equipment
PPL	Priority pollutant list
PWDS	Process Water Ditch System
RCRA	Resource Conservation and Recovery Act
RDCSCC	Residential Direct Contact Soil Cleanup Criteria
RECs	Recognized environmental conditions
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SVOC	Semi-volatile organic compound
SWMU	Solid waste management unit
TEL	tetraethyl lead
UST	Underground storage tank
VOC	Volatile organic compound
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

A Preliminary Assessment (PA) of the E.I. du Pont de Nemours and Company (DuPont) Chambers Works Complex (the site), performed in accordance with New Jersey regulations, has identified 11 areas of concern (AOCs) within the boundaries of the site where additional investigation is recommended along with sediment sampling at historical outfalls into surface-water bodies. The comprehensive evaluation of the 122-year site history combined with existing environmental and hydrogeological data further supports the conclusions of the previous conceptual site model whereby site related constituents are effectively contained by the on-site interceptor well system and prevented from migrating towards the surrounding communities[1]. Additionally, no AOCs were identified on off-site properties previously owned by DuPont. Based on the results of this Preliminary Assessment, no exposure to site-related constituents is indicated; therefore, there are no unacceptable risk to human health or the environment.

The PA reported here encompasses the 1,455-acre DuPont Chambers Works Complex located along the eastern bank of the Delaware River in Deepwater, New Jersey as well as off-site properties previously owned by DuPont. The PA was performed in accordance with N.J.A.C. 7.26E-3.1 and as part of the DuPont comprehensive program for long-term remediation developed in conjunction with NJDEP, which was specified in the DuPont letter to NJDEP dated July 1, 2005.

The purpose of a PA is to identify potential areas where contaminant sources are suspected. These suspected areas are considered AOCs. A PA is typically performed as an initial phase of site investigation and prior to implementing any remedial actions. However, DuPont has already completed four phases of the Resource Conservation and Recovery Act (RCRA) Facility Investigation and completed numerous remedial actions. Over the past 15 years, more than $150 million has been spent to investigate and remediate areas of the site. Many of these projects were initiated by DuPont and were facilitated by the cooperative working relationship with the NJDEP and the EPA.

The PA described herein was performed with the use of a Geographic Information System (GIS) tool. The tool was presented to the NJDEP and EPA in August 2006 and was a crucial evaluation tool for the PA. In order to enable a detailed analysis of the abundance of information that characterizes the complex and extensive manufacturing history of Chambers Works, DuPont invested in the development of a comprehensive GIS and accompanying relational databases. The GIS includes digitized site plan maps from 1919 through 2005, 17 aerial photographs between 1940 and 2002, infrastructure features such as historical and current utilities, surface-water drainage, historical shoreline, landfills, current solid waste management units (SWMUs), current and historical outfalls, historical process wastewater ditches and historical internal building trench locations, locations of public water supply wells, and numerous other geographic and geologic information. The GIS is linked to an environmental analytical database and

[1] A small component of shallow groundwater flow toward the Delaware River exists along the western portion of the Chambers Works complex. DuPont is currently conducting additional investigations to assess potential migration of site-related constituents into the river.

a process history database. The analytical database contains the results from more than 19,000 environmental samples collected at about 3,223 locations. The historical process database is based on historical files that were reviewed by 12 retired Chambers Works scientists. A total of 230 file drawers of detailed process/manufacturing data were reviewed and entered electronically into the database. Both the analytical and process history databases are linked to the GIS, which was then used to evaluate and integrate analytical, spatial, and historical data to identify the potentially contaminated areas of concern.

DuPont has committed to a long-term comprehensive remediation program that builds on and integrates the current understanding of the Chambers Works site. The goal of this program is to focus future remedial actions in order to achieve environmental results. Development of the GIS tool, and its continued upgrade, will be used in a systematic process of source identification, evaluation, and testing consistent with NJDEP and EPA regulations.

As a result of the comprehensive evaluation of the Chambers Works Complex history as well as the existing environmental data, the PA identified 11 AOCs, all of which were located in the active Chambers Works manufacturing area. No off-site areas of concern in the surrounding communities were identified through this comprehensive evaluation nor was any expousre to site-related consituents indicated. The Chambers Works manufacturing area was the center of research and development as well as manufacturing of a wide range of products. Manufacturing and support buildings were constructed and frequently converted to meet the needs of production. Previous investigations within this area have indicated the presence of process-related constituents (primarily volatile organic compounds and semi-volatile organic compounds) in soil and groundwater. The PA identified additional suspected source areas for further evaluation.

Areas that warrant further investigation were also identified for the former Carneys Point Works, located in the northern portion of the site. However, these areas were not designated as AOCs. Further investigation of these areas will be conducted as part of the ecological investigation for Carneys Point.

Most of the AOCs in the Chambers Works manufacturing area encompass large manufacturing areas where particular products were produced and are relatively large in area. Nine AOCs are between 20 and 80 acres. Ten of the AOCs are contiguous such that nearly the entire southeastern portion of the site is defined by AOCs.

Although the identified AOCs are large in size, specific potential sources have been identified, such as a known chemical release location or chemical loading/unloading areas, for example. Suspected or known groundwater contamination was also used to aid in defining AOCs. Groundwater may act as a source to downgradient groundwater and potentially to the sediment and surface water in downgradient water bodies through groundwater to surface-water pathways.

Sections of the former process wastewater ditch system are present in ten of the 11 AOCs. Although the majority of these earthen ditch sections have been remediated, there is a potential that soil beneath the former ditches or dense nonaqueous-phase liquid (DNAPL) may be present at depth and acting as a source to groundwater contamination at some locations. High concentrations of SVOCs in some wells that are adjacent to and

downgradient of ditch sections support this hypothesis. Given the irregular distribution of ditches and the extensive network of process building trenches associated with the ditch system, defining specific portions of ditches as individual AOCs is not possible at this time.

The AOCs resulting from this comprehensive analysis are as follows:

- AOC 1: Fluoroproducts
- AOC 2: TEL
- AOC 3: Jackson Labs
- AOC 4: Aramids
- AOC 5: Historical Basin Footprint and Ditches
- AOC 6: Dyes
- AOC 7: Elastomers
- AOC 8: Warehouse, Transport and Construction
- AOC 9: Monastral
- AOC 10: White Products
- AOC 11: Former Drainage Ditch

DuPont recommends additional investigation within the AOCs, and the recommendations are presented in this report. In general, recommendations were developed to meet the following objectives:

- Evaluate B Aquifer groundwater quality downgradient of potential sources in areas of the site where insufficient data exists. Assessing groundwater quality in these areas will help to determine whether an area is (or was) a source to groundwater.
- Increase spatial characterization of B Aquifer hydraulic gradients near the site perimeter to confirm hydraulic containment by the Interceptor Well System (IWS).
- Further refine understanding of potential groundwater to surface-water pathways by installing additional perimeter monitoring wells.
- Evaluate soils that may be acting as sources to groundwater by further characterizing the distribution of elevated concentrations.
- Evaluate sediment quality in the vicinity of historical process wastewater outfalls along the Delaware River and Salem Canal.
- Further evaluate soil, sediment and surface water quality in Carneys Point as part of the Ecological Risk Assessment for Carneys Point.
- Refine the location/boundaries of several SWMUs based on review of more accurate aerial photographs and GIS data.

Details regarding the recommended investigations, such as the location and number of wells, and the sampling methodologies, will be provided in subsequent work plans following agency review of this PA.

1.0 INTRODUCTION

This Preliminary Assessment Report (PAR) presents the results of the Preliminary Assessment (PA) completed for the E.I. du Pont de Nemours and Company (DuPont) Chambers Works Complex (the site), made up of the Chambers Works manufacturing area and the former Carneys Point Works, in Deepwater, New Jersey. This PA was conducted in accordance with N.J.A.C. 7:26E-3.1 and reported herein in accordance with N.J.A.C. 7:26E3.2.

1.1 Regulatory Background

The Chambers Works Complex has completed four phases of Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) under the direction of the U.S. Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP). The RFI at the site has been phased to evaluate and prioritize solid waste management units (SWMUs) within the site, so that remedial actions can be focused on SWMUs that may potentially present a greater risk to human health or the environment. The phased approach enabled three overlapping sets of objectives to be addressed:

- Achieve site stabilization.
- Advance the site through the RCRA Corrective Action Process.
- Address high priority SWMUs on an accelerated schedule, outside of the phased, RFI process.

At the request of NJDEP, DuPont developed a comprehensive program for long-term remediation at the site and for addressing the potential discharge of contaminated groundwater and surface water to the Delaware River and its tributaries. The overall approach proposed for long-term remediation was to identify significant sources to groundwater and surface water and to evaluate the feasibility of remediating those significant sources. The July 1, 2005 letter to NJDEP included a comprehensive schedule that entailed both long-term and short-term projects. Optimization of groundwater recovery and enhanced groundwater monitoring were also presented in this comprehensive program.

DuPont has completed the first step of this comprehensive program. A geographical information system (GIS) based conceptual site model (CSM) was developed; this model integrates information on the site operational history, physical site features, existing CSM information, and existing environmental data. At the completion of the GIS database development, a presentation on the potential applications of this tool was demonstrated to NJDEP and EPA on August 16, 2006.

The GIS database was then used in the identification of potential source areas for the entire 1455 acres at the site. The initial source characterization efforts focused on the identification of data gaps along the perimeter of the site as well as internal manufacturing and waste management areas. Corrective Measures Studies of the currently identified SWMUs were also integrated into this long-term remediation

program. In discussions with NJDEP, it was agreed that the results of the CSM would be provided in a PAR.

1.2 Purpose of the Preliminary Assessment

As stated in N.J.A.C. 7.26E-3.1(a), the purpose of the PA is to identify the presence of any potentially contaminated areas of concern. The comprehensive GIS-based CSM compiled extensive information and allowed the integration of various site-specific data/information including site infrastructure, process history, natural physical features, subsurface geology, hydrogeology, and environmental analytical data. Using the GIS tool enhanced the ability to identify source areas, migration pathways, and data gaps.

This PAR also summarizes the GIS tool created for the site. The revised CSM is presented on a site-wide scale as well as by specific area. Potentially contaminated areas of concern were identified. This report presents the findings of the preliminary assessment and, for areas of the site where data gaps were identified, recommendations for filling those data gaps are provided.

1.3 Report Organization

This PAR addresses the entire Chambers Works Complex, including several off-site locations that are no longer owned by DuPont. The report is broken down into the following sections:

- Sections 1 through 3 provide background, history, and details about the approach and methodology used for the PA.
- Section 4 describes the site-wide evaluation.
- Sections 5 through 20 each describe a focus area (FA). The site was broken down into 16 FAs to facilitate the evaluation of the site. FAs are further discussed in Section 3.
- Section 21 presents the conclusions and recommendations.
- Section 22 contains the references cited in this report.

This report contains the following appendices:

- The first three appendices contain general information – EDR reports, a DuPont document list of all remedial investigations conducted at the Chambers Works site, and additional site history and regulatory background.
- Appendix D contains supplemental information about the site-wide evaluation. This appendix includes aerial photographs and a CD containing Adobe Acrobat pdf files. Each file contains tables specific to a focus area. The naming convention for these tables begins with a code designating the focus area (e.g., "WP" stands for "White Products"). Data included in these tables were previously presented to NJDEP in the relevant reports. Due to the number of tables, electronic submission was necessary to reduce the overall size of this PAR.

- Appendices E through T each describe supplemental information for a FA, including the aerial review for each focus area.
- Appendix U contains a CD with soil management data.

2.0 SITE BACKGROUND AND HISTORY

The 1,455-acre DuPont Chambers Works Complex (the site), made up of the Chambers Works manufacturing area and the former Carneys Point Works, is located along the eastern shore of the Delaware River in Deepwater, New Jersey (see Figure 2-1). The Carneys Point Works operated from 1892 to 1979 and produced smokeless gunpowder, nitrocellulose, and related products. The Chambers Works manufacturing area began producing dye in 1917 and gradually expanded as other product lines were added including Performance Chemicals, aramids, fluorochemicals, motor fuel antiknocks, and polymers. As a result of nearly 120 years of continuous industrial activity, Chambers Works is a complicated site. Historically, the Chambers Works Complex has been involved in the development of roughly 1,200 chemical products.

The site is located along the eastern bank of the Delaware River adjacent to the Delaware Memorial Bridge in Deepwater, New Jersey. The site extends approximately 2.7 miles between Helms Cove to the north and the Salem Canal area to the south.

The site is located in a moderately populated area consisting of light to heavy industry, recreational areas, community-service areas, and residential neighborhoods. Situated south of the site is the Conectiv (formerly Atlantic Electric) Power Plant. East of the site are light industrial, residential, and recreational areas. North of the site lies community service and residential areas. The Delaware River is to the west of the site.

The site lies within the Lowland Subprovince of the Atlantic Coastal Plain physiographic province (Barksdale, et al., 1958). The surrounding topography is gently rolling, with elevations ranging from sea level to 85 feet National Geodetic Vertical Datum (NGVD; 1929). Elevations at the site are typically within 10 feet above sea level.

In the 1960s, groundwater contamination was identified. In response, DuPont installed an interceptor well system (IWS) in 1970. The IWS was designed to collect potentially impacted groundwater and to restrict the off-site migration of groundwater for the protection of human health and the environment. The IWS has operated continuously since 1970, and has been optimized and mechanically upgraded to provide current extraction of more than 1.5 million gallons per day.

2.1 General Site History

As per requirements of a PAR as outlined in N.J.A.C. 7:26E-3.1 (c)(1)(ii)(4), the following paragraphs include a brief description of the past industrial usage of the Chamber Works Complex by DuPont. More detailed process and manufacturing history are presented in Sections 5 through 20 and in Appendix C.

The Chambers Works Complex traces its origins to 1892 when Carneys Point smokeless gunpowder plant was constructed at the northern end of Carneys Point. By 1914, gunpowder-manufacturing operations had extended south into what is currently the Chambers Works manufacturing area. The Carneys Point Works was operational from 1892 to the mid-1970s, producing nitrocellulose, smokeless gunpowder, and other products. In 1917, dye and specialty chemical manufacturing began at what was then

called the Dye Works (currently Chambers Works manufacturing area). Refrigerant (Kinetic or *Freon*®) and tetraethyl lead (TEL) production began in the 1920s, followed by aromatic chemical manufacturing in the 1940s. By the 1960s, Chambers Works began elastomers production.

As chemical manufacturing areas expanded, low-lying areas were filled in with river dredgings and other fill material to form a foundation for further development. By the late 1970s and early 1980s, the explosive and dye manufacturing divisions were discontinued, leaving only chemical manufacturing. Most of the Carneys Point buildings were razed by 1979, leaving behind only building foundations.

Historically, the Chambers Works Complex has been involved in the development of more than approximately 1,200 chemical products. The following is a list of some of the major manufacturing areas, past and present, and some of their associated process chemicals (DuPont, 1998).

2.1.1 Carneys Point Powder Plants

The plants operated from 1892 to 1979 and consisted of Plants 1, 2, 3, and 4 in the early 1900s. The plants produced nitrocellulose and gunpowder. The materials involved in production included ether, amines, plasticizers, nitrotoluenes, nitroglycerin salts, nitric acid, and sulfuric acid. Off-quality nitrocellulose was the primary waste from this area.

2.1.2 Dye Works Plant (Chambers Works Manufacturing Area)

Dye production operated between 1917 and the early 1980s producing more than 700 different dyes:

- ❑ Dye Manufacturing: This manufacturing division consisted of the following seven areas, each producing sludges and nitrobenzene wastes:
  - Azo Colors: This manufacturing division used organic mercury, amino constituents, benzene, phenols, acids, aniline, toluidine, sulfur, and naphthalene.
  - Basic Colors: Chemically, the products for this manufacturing division included primarily basic and acid dyes of the triarylmethane series and azine series.
  - Sulfur Colors: This manufacturing division used sulfur and sodium sulfides; sulfur black was the first dye produced at the Dye Works, starting in 1917.
  - *Ponsol*®:This manufacturing division used sodium hydroxide, sodium hydrosulfide, aluminum chloride, and sulfuric acid.
  - Monastral® Colors: This manufacturing division used blue and green pigments. The manufacturing operations were a section of the *Ponsol*® area organization and used similar chemicals.
  - White Products: This manufacturing division involved the use of aromatic hydrocarbons, chlorinated aromatics, polymers, elastomers, fibers, and anilines.
- ❑ Indigo Heavy Chemicals Area: This area began operation in 1917, producing indigo dye, sulfuric acid, and chlorine. Other chemicals associated with this area

included sodium hydroxide, hydrochloric acid, ammonia, sodium, sulfur, benzene, nitrobenzene, nitrotoluene, chlorobenzene (CB), methylamines, and ethyl chloride.

- Fluorochemicals Production Area: This area produces *Freon*® products. It began operations in the 1920s and manufactured fluorinated hydrocarbons from hydrofluoric acid, sulfuric acid, hydrochloric acid, carbon tetrachloride, fluorospar (solid), antimony, pentachloride catalyst, and perchloroethylene (PCE). DuPont has phased out chlorofluorocarbon (CFC) production and replaced it with the *SUVA*® product line, which includes hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs).
- Motor Fuel Antiknock Production Area: This area produced motor fuel antiknock compound (MFAC), which contained tetrethyllead (TEL) and tetramethyl lead from sodium, ethylene, methanol, methyl chloride, and ethyl chloride. The lead alkyls are the primary waste from this area. TEL production began in the 1920s and was discontinued in the spring of 1991.
- Petroleum Chemicals: This manufacturing area produces oil additives. Organic amines and methacrylate polymers are made in this area.
- Polymer Products Manufacturing Area: This area produces *Hylene*®, *Hytrel* ®, plastics, and Viton® elastomers using organic isocyanates, phosgene, dinitrotoluene, and hydrochloric acid.
- Aromatics and Specialty Chemicals: This manufacturing area began production in the 1940s and is still one of the primary manufacturing areas. Materials involved in this area include petroleum hydrocarbons, acids, solvents, inorganic constituents, and aromatic hydrocarbons.

2.1.3 Property History

Per N.J.A.C. 7:26E-3.1(1)(ii) (1) through (3), the PAR must include without limitation the names of all the owners and operators, as well as dates of ownership and dates of operation of each operator from the time that the site was naturally vegetated. The following section contains a general summary of the property history associated with the Chambers Works Complex. Property history details are provided in Appendix D. This appendix contains the DuPont Chambers Works real estate inventory map (#2506) and identifies all conveyances, easements, or agreements associated with the property from 1915 to present. Property history before 1915 is documented in DuPont Chambers Works History 1891-1958, dated 1978. Individual focus area history sections describe in more detail whether additional operators are/were operating at the site.

From 1685 to 1891 the area currently identified as the Chambers Works Complex was used for farming or was unused wetlands or tidal marshes. There is no information on the types of agricultural operations that were conducted in the area. On July 19, 1891 The DuPont Powder Company purchased the Thomas Carney farm and constructed the Carneys Point Works. DuPont purchased additional parcels of adjacent land as the Carneys Point Works expanded between 1891 and 1915. These additional parcels were

consolidated into the contiguous Carneys Point Works that extended from Helm's Cove to Salem Canal.

From 1915 to 1918 portions of the Carneys Point Works in Deepwater Point were conveyed from the DuPont Powder Company to the DuPont Chemical Company for the construction of the Deepwater Dye Works. Between 1917 and 1927, additional parcels were purchased by the DuPont Chemical Company as the Deepwater Dye Works expanded. These additional parcels included a residential community along the Delaware River north of the Salem Canal known as Fenton's Beach.

From 1927 to present, the contiguous property identified as the Chambers Works Complex has been owned and operated by DuPont. There is no operational information available concerning previous agricultural or residential land use activities prior to the DuPont purchase of individual properties.

2.2 Current Conditions and Manufacturing

Approximately 650 acres of the Chambers Works Complex are currently developed. The Chambers Works Complex produces approximately 600 products using about 1,500 processes in 44 manufacturing buildings. The manufacturing areas at Chambers Works currently include the following:

- Organic intermediates and aromatics
- Petroleum chemicals
- Fluorochemicals
- Polymers and elastomers
- Specialty chemicals
- The RCRA-permitted secure landfill, also known as the Secure C Landfill, which is located north of Henby Creek and the wastewater treatment plant (WWTP).
- An electric cogeneration facility and gas production facilities run by third parties, which are located within the Chambers Works Complex

2.3 Manufacturing History

The general manufacturing history at the site is described in Appendix C. Details about specific process histories are described in each focus area section, as needed.

2.4 RCRA Corrective Action Regulatory Background

The Chambers Works Complex is subject to a variety of federal and state environmental regulations. The Chambers Works RCRA corrective action program is under the jurisdiction of the United States Environmental Protection Agency (EPA) as a result of the 1984 Hazardous and Solid Waste Amendments (HSWA). A chronological list of major documents and permits related to the corrective action program are summarized below.

2.4.1 Administrative Consent Order, 1984

A New Jersey Department of Environmental Protection (NJDEP) Administrative Consent Order (ACO) was issued in 1984 and later amended in 1988. This ACO required DuPont to implement remedial action at the A, B, and C Basins and the Process Water Ditch System (PWDS), which are SWMUs 14, 15, 16, and 17, respectively. These SWMUs were investigated, remediated, and closed in accordance with the NJDEP ACO, New Jersey Pollution Discharge Elimination System-Discharge to Groundwater (NJPDES-DGW) permit, and approved closure plans. The Remedial Action Report for the C Basin closure was approved by the NJDEP on October 10, 1995. The Remedial Action Report for the A/B Basin closure (except for the A Basin vault) was approved by the NJDEP on June 26, 1997. The Remedial Action Report for the PWDS was approved by the NJDEP on December 2, 1997. The A Basin vault received material from the SWMU 56 (ODCB in B Ditch) Interim Stabilization Measure (ISM), the SWMU 5 ISM and material from the SWMU 52 ISM. The A Basin vault was closed in October 2006. A closure report will be submitted to NJDEP in 2007.

2.4.2 Hazardous and Solid Waste Amendments Permit, 1988

The EPA issued a HSWA permit (No. NJ002385730) to Chambers Works effective November 7, 1988. The HSWA permit requires DuPont to determine the nature, extent, and migration rate of hazardous waste and/or hazardous constituents in soil, groundwater, surface water, subsurface gas, and/or air at any SWMU regardless of the time that the waste was placed in the unit, and to develop corrective action for any releases as appropriate.

2.4.3 Draft RFI Work Plan, 1989

A Draft RFI Work Plan was submitted to the EPA and NJDEP in 1989. The work plan was not implemented. In a July 1992 meeting with the EPA, a decision was made that the proposed work plan was out of date and that DuPont would submit a Current Conditions Report to provide an update of site activities since the Draft RFI Work Plan had been submitted.

2.4.4 Current Conditions Report, 1992

DuPont submitted a Current Conditions Report to the EPA dated December 18, 1992. The primary purpose of this report was to summarize the existing data on the SWMUs and to present additional environmental information collected at the site since 1989 when the Draft RFI Work Plan was submitted.

DuPont received comments on the Current Conditions Report from the EPA and NJDEP on March 25, 1993. Included in the EPA review was a request for a new Phase I RFI Work Plan.

2.4.5 HSWA Permit Renewal Application, 1993

On May 7, 1993, DuPont submitted an application to the EPA for renewing the Chambers Works HSWA permit, six months prior to the November 7, 1993, expiration date of the existing permit. The Regional Administrator has not issued a new HSWA permit. Therefore, in accordance with 40 CRF 270.51, the 1988 HSWA permit remains in effect until a new permit is issued.

2.4.6 Phase I RFI, 1993-1995

DuPont prepared a Phase I (June 1993) and Phase IA (August 1993) RFI Work Plan, which EPA conditionally approved in December 1993. The Phase I RFI was implemented in 1994 and 1995.

DuPont submitted the results of the Phase I RFI in a May 1995 report. The Phase I RFI Report recommended the following activities for the Phase II RFI:

- Groundwater sampling to be more focused on the deeper aquifers
- Dense non-aqueous phase liquids (DNAPL) investigation focused in areas of potential migration as identified in the Phase I Investigation
- Investigation of twelve SWMUs

2.4.7 Phase II RFI, 1996-1998

DuPont prepared a Phase II RFI Work Plan (May 1996) and a Revised Phase II RFI Work Plan (November 1996). EPA and NJDEP approved the Revised Phase II Work Plan in 1997. The Phase II RFI was implemented in 1997 and 1998.

DuPont submitted the results of the Phase II RFI in the October 1998 report. The Phase II RFI report recommended the following activities for the Phase III RFI:

- B Aquifer Tidal Study
- Continue investigation at three SWMUs
- Characterization of five SWMUs

2.4.8 Phase III RFI, 2000-2002

DuPont prepared a Phase III RFI Work Plan (April 2000) and submitted subsequent correspondence addressing Agency comments. EPA and NJDEP approved the Phase III Work Plan in April 2001. The Phase III RFI was implemented from May through September 2001.

DuPont submitted the results of the Phase III RFI in the April 2002 report. The Phase III RFI report recommended the following activities:

- Provide additional investigation of four SWMUs.
- Conduct ISMs at three SWMUs.

2.4.9 SWMU 8, 2003-2004

DuPont prepared two work plans for the 2003 Test Pit activities and for the 2004 Remedial Investigation (RI) activities and submitted subsequent correspondence addressing agency comments. The EPA and NJDEP approved both work plans. The SWMU 8 RI activities were implemented from May to September 2004. DuPont submitted the results of the field activities in a report dated February 15, 2005.

2.4.10 Environmental Indicator CA725, June 2004

In June 2004 EPA determined that Chambers Works met the Government Performance and Results Act criteria of Environmental Indicator CA 725, current human exposures under control.

2.4.11 SWMU 52, July 2004

DuPont prepared a Remedial Action Selection Report (RASR) for proposed Interim Stabilization Measures (ISM) at SWMU 52 and implemented stabilization activities starting in the summer of 2006. A more detailed description of the SWMU 52 activities to date is provided in the Carneys Point FA (see Section 20).

2.4.12 Environmental Indicator CA750, September 2004

In September 2004 EPA determined that Chambers Works met the Government Performance and Results Act criteria of Environmental Indicator CA750, migration of contaminated groundwater under control.

2.4.13 Phase IV RFI Phase IV RFI and Phase IV RFI Supplemental

A Phase IV RFI RCRA Report was submitted to the EPA and NJDEP on April 22, 2005. The report consisted of three sections: investigation of five individual SWMUs, a baseline ecological evaluation (BEE), and an E Aquifer hydrostratigraphic study. The report recommended some additional delineation and evaluation for specific SWMUs, which is currently being completed under the Phase IV RFI Supplemental Work Plan. A report of findings will be submitted to the agencies in the first half of 2007.

The results of the BEE indicated that additional ecological investigation was necessary. With agreement from NJDEP, the BEE report was separated from the Phase IV RFI documentation and will follow its own timeline for completion. A revised independent BEE was submitted to the NJDEP in September 2006. An ecological investigation work plan will be delivered to the NJDEP in the 1st quarter 2007.

The overall key conclusion of the E Aquifer hydrostratigraphic study was that the E Aquifer appears to be impacted only where leaky well casings allow downward migration. Select E Aquifer wells were abandoned in 2006 with concurrence with NJDEP, and information concerning these abandonments will be submitted as part of the Phase IV RFI Supplemental Report.

2.5 Environmental Permits

In accord with NJDEP Technical Regulations N.J.A.C. 7:26E-3.1(c)(4) (xii), all federal, state, and local environmental permits (including permits for all previous and current owners or operators, applied or received, or both) for the site need to be identified. The Chambers Works Complex is subject to a variety of federal and state environmental regulations and permits, and during various remedial activities, numerous permits have been received. The specific permits for remedial actions will not be listed; instead the reader is referred to the existing remedial reports for details. The site-wide permits that are currently in effect are as follows:

- Hazardous and Solid Waste Amendment (HSWA) Permit
- Secure C Landfill Permits
- NJPDES-Discharge to Groundwater Permits
- NJPDES-Discharge to Surface Water Permit
- Water Allocation Permit
- NJDEP Title V Operating Permit
- Other Environmental Permits

For details about each permit, see Appendix C.

2.6 Regulatory Background on the RCRA Remedial Facility Investigation Process under the HSWA Permit

In accordance with the N.J.A.C 7:26E-3.1(c)(4)(ix), the PAR must list all remedies previously approved by NJDEP in a remedial action work plan. DuPont maintains stabilization of the site both by interim stabilization measures (ISMs) and operation of the IWS. ISMs have been implemented at SWMU 5 and SWMU 43, SWMU 52, SWMU 56 (Aramids Pond), SWMU 56A, and SWMU 45-9 (footprint of proposed Landfill D). DuPont also has implemented a site-wide non-aqueous phase liquid (NAPL) study and recovery program to address recoverable amounts of NAPL when detected. More details concerning the current site strategy are provided below.

2.6.1 SWMU Investigation Status

According to the EPA May 1994 RCRA Corrective Action Plan (Final), the objective of a corrective action program is to "evaluate the nature and extent of the releases of hazardous waste or constituents; to evaluate facility characteristics; and to identify, develop, and implement an appropriate corrective measure or measures to protect human health and the environment."

The Corrective Action Plan further states:

> "While final cleanup remains the long-term goal of the corrective action program, the RCRA Implementation Study (RIS) recommended more frequent use, where appropriate, of interim/stabilization measures in early stages or corrective action

to achieve near term environmental protection at facilities with the most serious problems. This approach, which may also be appropriate during later phases of the process, emphasizes controlling sites by stabilizing identified releases to prevent the further spread of contamination and degradation of the environment."

The DuPont Chambers Works corrective action process during Phases I through IV RFI has focused on characterizing and stabilizing the site with the emphasis on the site perimeter. The RFI process at Chambers Works has been phased to evaluate and prioritize SWMUs within the site, so that remedial actions can be focused on SWMUs that may potentially present a greater risk to human health or the environment (see Table 2-1 and Figure 2-2). The phased approach enabled three overlapping sets of objectives to be addressed:

- Achieve site stabilization.
- Advance the site through the RCRA Corrective Action Process.
- Address high priority SWMUs on an accelerated schedule, outside of the phased RFI process.

Overall, the site strategy is to achieve stabilization of the site such that there are no unacceptable risks to human health or the environment. Stabilization is achieved when all the potential exposure routes for site constituents are controlled or remediated. Future work at Chambers Works under RCRA will start with the development of corrective measure studies in support of remedial alternative evaluations and selection starting with the SWMUs with the greatest potential impact to groundwater (e.g., SWMU 8).

2.6.2 Interceptor Well System

DuPont maintains stabilization of the site groundwater through the use of the IWS and the implementation of ISMs. The IWS is the primary method of maintaining site stabilization at Chambers Works. It consists of three primary and three backup recovery wells and is operated in accordance with NJPDES-DGW Permit No. NJ0083429. Currently, the IWS consists of six wells at the interior of the site to recover groundwater from the C and D Aquifers (see Figure 2-3). The IWS has operated since 1970 and is currently pumping and treating a monthly daily average minimum of 1.5 million gallons per day (1.5 mgd) of groundwater to achieve control. Potentiometric contour maps, supplemented with modeling, have demonstrated that all of the impacted groundwater at Chambers Works is contained by the IWS in the C, D, and E Aquifers. Additional modeling has shown that the small percentage of impacted groundwater in the B Aquifer that migrates off-site does not pose an unacceptable risk to human health and the environment (DuPont, 2004).

DuPont will continue to use the IWS to maintain stabilization. Previously, DuPont concluded that additional steps could be taken to improve the groundwater quality at the site. Specifically, potential areas are being evaluated where additional sources to groundwater – in addition to the DNAPL recovery program – may be remediated. DuPont also is evaluating ways in which groundwater pumping may be reduced to better manage groundwater resources, while still maintaining containment of affected groundwater.

DuPont expects to submit a groundwater modeling and evaluation report to the NJDEP in mid 2007.

Contamination of groundwater in the surficial aquifers at the Chambers Works Complex has been recognized for some time. Under various regulatory programs, DuPont has been working with the NJDEP and the EPA to identify sources of contamination, implement corrective actions where needed, and improve or replace systems that cause or could cause releases to groundwater. The *Current Conditions Report* (DuPont, 1992) and the *Phase II RCRA Facility Investigation Report* (DuPont, 1998), Phase III and Phase IV RFI provide detailed descriptions of the ongoing investigations of potential sources of contamination and the current groundwater quality across the site.

As mentioned, the IWS currently includes six recovery wells in the central area of the site that withdraw an average minimum of 1.5 million gallons per day. The removal of this groundwater induces flow gradients toward the interior of the site and, consequently, helps ensure that groundwater in the underlying B, C, and D Aquifers does not leave the site. Groundwater elevations are monitored semi-annually in over 300 wells, and groundwater elevation contour maps are created from the resulting data.

Well measurement data have documented the zones of influence of the IWS wells (cones of depression). The design of the system requires continual refinement as additional information about the hydraulic properties of the subsurface materials is developed and as the activities in various areas of the site change. These data are used to evaluate the effectiveness of site-wide groundwater containment and are presented in semiannual summary status reports on April 30 and October 31 of each year. The reports are submitted in accordance with Part IV.F of the NJPDES-DGW Permit No. NJ0083429 and provide results of groundwater monitoring programs and the status of corrective action programs.

2.6.3 Classification Exception Areas

Pursuant to the February 1, 1993, Groundwater-Quality Standards (N.J.A.C. 7:9-6 et seq.), the NJDEP has designated two classification exception areas (CEAs) for the groundwater beneath the Chambers Works Complex in Pennsville and Carneys Point Townships (see Figure 2-4). The Department based this decision on the following:

- The groundwater at the site is hydraulically controlled by groundwater recovery systems necessary for the protection of human health and the environment.
- DuPont signed an Administrative Consent Order with the Department in which DuPont committed to remediating the RCRA land disposal units at the site.
- DuPont is complying with their EPA Hazardous and Solid Waste Management Permit, which requires DuPont to identify and reduce the sources of contamination on-site.
- Use of the property for industrial purposes is expected to continue in the future.
- The constituent standards have been exceeded for a number of constituents at the site.

A Classification Exception Area (CEA) has the effect of suspending the designated uses [potable Class IIA Quaternary Aquifer and Potomac Raritan Magothy (PRM) Aquifer System beneath the site] and constituent standards in the indicated area of operation of the recovery systems for the duration of this NJPDES-DGW Permit. The southern portion of CEA 1 includes groundwater beneath Lots 1,2,3,4 & 5, of Block 301, Pennsville Township, Salem County. The northern portion of CEA 1 includes Lots 1, 2, and 3 of Block 185 and Lot 5, Block 193 of Carneys Point Township, Salem County to a depth of approximately 200 feet. CEA 1 now includes the ball fields in Lot 5, Block 193. CEA 2 includes groundwater beneath Lots 1 and 2 of Block 185, Carneys Point Township, Salem County, to a depth of approximately 200 feet. The NJPDES-DGW Permit No. NJ0083429 lists the compounds for which the constituent standards are suspended for the duration of the permit.

3.0 EVALUATION APPROACH AND METHODOLOGY

This section describes the approach and methodology used to identify potentially contaminated areas of concern at the site that warrant additional investigation. As described below, the approach and methodology included developing a comprehensive Geographic Information System (GIS) and accompanying databases of site analytical data, historical process information, and spatial data. This GIS was used as an investigative tool. Other elements of the approach included the division of the site into focus areas and implementing a conceptual model of migration pathways for use as a basis for integrating analytical data with site process information. This approach was used for all areas of the site, including areas not previously designated as SWMUs or areas of concern (AOCs) under the RCRA CA program and the ACO with NJDEP (1984, 1988). The final step in the approach was evaluation of the site as a whole as described in Section 3.8.

Importantly, Section 3.3 provides a description of the New Jersey Technical Requirements for Preliminary Assessments, and it references where each required element is presented, or how it was implemented, in this report.

3.1 Background

DuPont has committed to a long-term comprehensive remediation program that builds on and integrates the current understanding of the site. The goal of this program is to focus future remedial actions in order to protect human health and the environment. As part of this long-term focus, DuPont proposed to follow a systematic process of source identification, evaluation, and testing consistent with NJDEP regulations. EPA RCRA CA, NRC and ITRC publications were consulted for additional technical guidance. As part of this systematic process, DuPont developed a geographical information system (GIS) that enables integration of site operational history, analytical data of environmental sampling, and spatial data. The GIS was used to as the main tool for integrating and evaluating the data.

The objectives of this evaluation are to answer the following questions:

- What are the historical site conditions and practices that may have resulted in releases to the environment and what constituents are likely to have been released?
- What are the pathways through which constituents may have been or are transported into environmental media (receptor media)?
- What are the potential impacts of these constituents on receptor media?
- What additional investigations are needed to evaluate the presence and/or effects of known or potential historical sources?

In the following sections, the approach used to perform the evaluation is outlined first; development of the GIS tool and database are described second; the methodology used to implement the approach is described third.

3.2 Approach

Numerous investigations have been performed at the site, including four phases of RFI and other area-specific investigations and remedial measures. As part of these investigations, contaminant sources have been identified and remediated, as appropriate. The work performed as part of this PA was executed for the entire site and for areas that were not previously evaluated in detail. Specifically, the identification of potential sources and impacted receptor media described in this report was performed by executing the following tasks:

- Developed a GIS and accompanying analytical database for the site. Together, these features constitute the Chambers Works GIS.
- Subdivided the site into focus areas (FAs) based on past production history and for evaluation purposes.
- Developed a conceptual site model of how contaminants migrate from sources to other environmental media (e.g., groundwater, sediment, surface water).
- Identified manufacturing processes (including raw materials, intermediates, products, and wastes) and, to the degree possible, quantified corresponding production rates, based on review of the process history database, literature review, and interviews with site retirees. In addition, the waste disposal methods and waste streams were identified using these information sources.
- Identified potential historical or current contaminant sources and receptor media based on an analysis of soil, sediment, surface water, and groundwater data, process history data and spatial data (site maps, aerial photographs, e.g.), and based on the conceptual model of contaminant migration. This methodology is referred to as a *pathway analysis* in this report.
- Based on the results of the FA evaluations, presented the results and the overall revised conceptual model of potential sources and migration pathways on a site-wide scale.
- Identified areas where additional investigation is recommended in order to confirm the presence of a source and the potential impact to surrounding media.

The approach and methodology were developed such that they satisfy the requirements for a Preliminary Site Assessment, as described below.

3.3 NJDEP Technical Requirements for Preliminary Site Assessment

According to the New Jersey Technical Requirements for Site Remediation (Amendments Feb 3, 2003), subchapter 3, concerning Preliminary Assessment and Site Investigation, the "purpose of a preliminary assessment is to identify the presence of any potentially contaminated areas of concern." The assessment must be based on diligent inquiry.

Diligent inquiry according to N.J.A.C. 7:26 E-3.1 (c) must include evaluation of the following (bold text indicates where the information is located in this report):

- Historical information including maps, title and deed, site plans and facility as-built drawings, and NJ I-map Geographic Information System (GIS).
  Any aerial photographs and plant layout maps that were found for the site were placed into the Chambers Works GIS which is more fully described in Section 3. Plant layout maps not previously provided to the NJDEP are provided in Appendix D. NJ I-map information was also placed into the Chambers Works GIS.
- Site history from time the site was naturally vegetated including names of all owners, dates of ownership of each owner, and dates of operation of each operator.
  A brief description of the site history and property transfers is described previously in Section 2. Additional information is provided in the figures in Appendix D.
- Past and present production processes, including dates, potential water use, ultimate potential discharge and disposal points and how and where materials are or were received on-site.
  A brief description of historical through current production history is summarized in each focus area and information regarding dates and potential discharge or disposal points, if any, is also noted on the Chemical Process data tables (see Appendix D). Material loading/unloading are discussed in each FA, if applicable.
- All former and current containers, container or bulk storage areas, above and below-ground tanks, above and below-ground waste and product delivery lines, surface impoundments, landfills, septic systems and other structures, vessels, conveyances or units that contain or previously contained hazardous substances, hazardous waste, and pollutants.
  Review of areas of bulk storage and tanks was part of the pathway analysis for each focus area and part of the aerial photograph review summary, which can be found in respective focus area appendices.
- For sites that exceed 2 acres, an aerial photograph history of site must be completed back to 1932 or the earliest photograph available.
  Individual focus area aerial photograph reviews are contained in respective appendices. The earliest available aerial photographs dates to 1940.
- Any data or information concerning known discharges that have occurred on the site.
  The site currently maintains a database as part of its spill control plans and is submitted to the NJDEP. In addition, a phase I type of outside vendor database review of releases was completed and downloaded and placed in Appendix A.
- All Federal, State and local environmental permits including permit identification number, application date, date of approval, denial or status, permit expiration

date.
Permits are described in Section 2.5 and in Appendix C.

- All administrative, civil and criminal enforcement actions for alleged violations of environmental laws concerning the site.
  DuPont is requesting a variance on summarizing this information at the current time.
- All areas where non-indigenous fill materials were used to replace soil or raise the topographic elevation of the site, including dates of emplacement.
  Areas of fill were noted during the aerial photograph review and are summarized in each focus area as necessary.
- Remediation activities previously conducted or currently underway at the site including dates of previous remedial actions, and all existing sampling data concerning contaminants at the site.
  Remedial activities are summarized in each focus area section.
- All existing environmental sampling data concerning contaminants at the site.
  Data tables were queried from the DuPont Environmental Database (Envista®) for all media, soil, sediment, surface water, groundwater, and non-aqueous phase liquids (NAPL). Tables are included in Appendix D. Soil Management data are also included in Appendix U.
- Site visit.
  DuPont is requesting NJDEP to grant a variance on the requirement of a site visit, due to the fact that personnel who worked on this evaluation and report are assigned by the DuPont Corporate Remediation Group, along with personnel from the Alliance contractor URS-Diamond, to the Chambers Works Complex and visit it on a daily or regular basis.

3.4 Chambers Works GIS

The GIS was built, in part, to help execute the site assessment described in this report. Notably, the GIS stores and handles site data in a way that provides a dynamic tool for integrating analytical, spatial, and historical data in accord with the NJDEP Preliminary Assessment requirements of diligent inquiry. Specifically, it helped to identify potentially contaminated areas of concern.

More generally, the GIS was developed to support strategic decision-making about the site in the future. Besides its use as an investigative tool for the assessments described here, the main goal of developing the GIS was to help update the CSM for the Chambers Works Complex and to facilitate future updates to the CSM as additional spatial and analytical data are collected (e.g., during future investigations, remedial activities, and from ongoing site monitoring efforts). The CSM developed for the Chambers Works Complex reflects the current understanding of historical and existing site conditions, past and current contaminant sources, environmental fate, and transport of contaminants.

Spatial and analytical data are managed with a GIS database and a relational database, respectively. Many sources of data were collected for incorporation into the GIS database, as described in the following sections.

3.4.1 The GIS Database

Information was gathered and evaluated as described below to meet the requirements of the NJDEP Tech Regulations as previously outlined in Section 3.3. The following spatial data were either scanned or digitized and loaded into the GIS database for review by each focus area evaluator:

- Site plan maps from 1919, 1939, 1945, 1952, 1963, 1967, and 2005. From these maps, 860 structures were digitized, and 165 were identified as process buildings.
- Historical and current infrastructure features (e.g., sea walls, bulkheads, surface water drainage, historical shoreline)
- Landfills, surface impoundments, and conveyances
- Current and historical outfalls
- Historical internal building trench locations identified from library archives and ditch locations (26.5 miles of drainage ditches and trenches)
- Utility maps (well water, sanitary water, river water, fire water, and natural gas)
- Current SWMU map (includes 63 SWMUs)
- Historical aerial photographs (dated 1940, 1942, 1943, 1944, 1946, 1951, 1953, 1954, 1956, 1959, 1962, 1964, 1974, 1979, 1995, 2001, 2002)
- Selected NJ IMAP layers (Public Community Water Supply Wells, Coastal Flooding Areas, etc.)
- Potentiometric maps (1999 to 2005) including 612 well locations (369 active and 243 abandoned)
- Geologic Maps (both Isopach and Top of Aquifer Structure)
- Current topographic map

The data collected from these various sources were merged into the GIS using the following procedures:

- Electronic aerial photographs collected from various sources were loaded directly into the GIS because these photographs already were based on the NJ State Plane coordinates; no modifications were necessary before uploading them into the GIS. Historical aerial photographs were scanned into an electronic format and digitally orthorectified and then loaded into GIS. The 2002 aerial photograph of the site is shown in Figure 3-1.
- Scanned map images, such as plant layout maps with no coordinate system, were geo-referenced using the GIS and the 2002 aerial photograph. A minimum of three anchor/reference points (based on sharply defined and known points) were

assigned manually by the GIS operator to the scanned map. The GIS function was then engaged to place the image over the aerial photograph.

- A variety of drawings that originally were in AutoCAD and Microstation formats (based on the Chambers Works plant coordinate system) were converted to the NJ State Plane coordinate system (NAD 83). A coordinate transformation definition was set up between the Chambers Works system and the NJ State Plane system using the Tralaine (Version 5) program. The maps were then loaded as different layers in GIS.

Senior project personnel completed QA and review of the loaded GIS layers using comparison and cross-verification review techniques so as to check and verify correspondence between the original data and the derived data stored in the GIS. As part of building the GIS database, each layer (such as an aerial photograph) has a set of associated meta-data to ensure that the original source of the derived data sets is documented.

3.4.2 Environmental Analytical Database (Envista)

Environmental data are stored in the Environmental Database using the software Envista®. The database is the repository for all sample data collected at the site, and it includes two types of analytical data: qualified analytical data and soil management program data.

Qualified Data

- Total data set: 586,741 results in 19,260 samples from 3,223 locations
- Soil: 2,398 samples from 1,176 locations
- Groundwater: 8,782 samples from 716 locations
- Surface Water: 668 samples from 167 locations
- Sediment: 191 samples from 106 locations

The locations of soil samples, monitoring wells, surface and sediment samples are shown in Figure 3-2 through Figure 3-5.

The data in the database have been submitted to NJDEP in HazSite data deliverables in their respective original reporting documents.

Soil Management Data

From the early 1980s to present, soil analytical data have been generated as part of the soil management program on the site. Excess soil resulting from excavations and construction activities were sampled, mainly as composite samples, and analyzed for specific analytes. Concentrations were then compared to screening values to determine if these soils were acceptable for on-site reuse or disposal. In many cases, composite samples were collected from temporary holding containers that contained soil collected from different locations, and the analytical methods are not consistent for all samples. Therefore, soil management data provide qualitative to semi-quantitative information about analyte concentrations in soil, so the data are not suitable for determining potential areas of concern and subsequent risk management decisions. As a result, the soil

management data (also known as soil reuse data) were evaluated and compiled for this report although the emphasis was placed on the discrete sample analytical data that were collected under the RCRA program investigations.

3.4.3 Historical Process Database

Process data from historical files were reviewed by 12 retired Chambers Works scientists. A total of 230 file drawers of detailed process/manufacturing data were reviewed. These hard copy data were entered into the historical chemical database using a standard template to ensure completeness and accuracy. The database is linked to the GIS tool.

A total of 2,463 raw materials/intermediates/products/wastes were identified as a result of this process. In addition, 433 product lines (batch, continuous, pilot scale) were identified.

3.5 Focus Areas

The process for evaluating the site must consider its size, its long and complex manufacturing history, its extensive list of raw materials, intermediates, and products, as well as the voluminous existing documentation about the site. A summary of the data and information evaluation pursuant to N.J.A.C. 7:26E3-1(c)1vii, vii, ix, and x is required to be presented by area of concern and all phases of work for a particular area of concern need to be integrated into a single discussion of that area. DuPont developed the concept of focus areas to satisfy the requirements of an integrated discussion.

To help manage the evaluation process and discussion, the site was divided into 16 FAs. The FA boundaries are approximate, and areas of the site are interrelated, so discussion of one focus area will often refer to aspects of other adjacent focus areas. The 16 FAs are listed here in the order they are presented in the report (Figure 3-6 shows the FAs):

- White Products
- Dyes
- Jackson Labs
- Tetraethyl Lead (TEL)
- Fluoroproducts
- Aramids
- Triangle
- Basins
- SWMU 8
- Wastewater Treatment Plant (WWTP)
- Cogeneration (Cogen)
- Praxair
- Miscellaneous
- Current Off-Site Properties (Off-Site)
- Pharmaceutical
- Carneys Point

3.6 Conceptual Model of Potential Migration Pathways

As previously stated, the history of operations at Chambers Works spans more than 110 years with continuous changes in site operations. Locations of historical chemical releases and the subsequent fate and transport a chemical complicates the identification of areas of potential concern in this PAR. Existing analytical data focused on SWMUs and other areas of interest. Many of these areas have been adequately characterized and

recommended for no further investigation. At the same time, the process history, spatial data, and historical analytical data provide a means to identify areas of potential interest.

Identification of known sources, or identification of potential sources, was performed in an iterative manner by evaluating the process history, spatial data, and historical analytical data in the context of the following conceptual model:

- Organic and inorganic constituents: soils may act as a source for dissolved phase contaminants in groundwater, which can then migrate toward the site IWS or surface water bodies. Transport pathways were evaluated in the B Aquifer only because this shallow aquifer is closest to potential surface sources and is the dominant transport pathway in the subsurface. Transport pathways in the B Aquifer are defined by the groundwater flow directions (see Figure 3-7).
- Historical process wastewater may have impacted surface water and sediment by way of direct discharge to surface water bodies via outfalls along the site perimeter. These discharges could have impacted sediment, and some impacted sediments may still be present even though process wastewater discharges via outfalls was phased out between 1958 and 1975.
- Historical surface sources of liquid waste, either from the historical process wastewater ditches or from waste ponds, may have resulted in migration of dissolved phase or non-aqueous phase liquids (NAPLs) into the shallow B Aquifer. NAPL trapped in shallow soils and DNAPL at depth can act as an ongoing source to groundwater contamination which, as described above, can then migrate by way of groundwater flow toward the site IWS or surface water bodies.
- In some locations, uncertainty exists as to the presence of potential sources and migration pathways towards receptor media. In order to reduce uncertainty, the conceptual model was used along with the data maintained in the GIS to identify potential significant sources and migration pathways and therefore plan for additional investigations.

3.7 Focus Area Evaluations

Six environmental professionals performed the evaluations. All of these evaluators possess the training and experience needed to conduct the evaluations properly and were supported by the information available to them in the GIS, in the Envista database, and from interviews with current and former employees at the Chambers Works Complex.

The evaluators identified process, manufacturing, storage areas, and other associated structures or features within each FA based on reviewing aerial photographs, evaluating building maps, and interviewing employees/retirees. The chemical process database was used to generate lists of raw materials, intermediates, products, and wastes that were associated with the buildings located in each of the focus areas.

Envista was queried for data associated with each focus area. Analytes were compared to applicable criteria and are presented for each focus area by media (groundwater, soil, sediment, surface water, and other as applicable). In some cases, a one-time grab sample of groundwater or surface water was collected. Results of these samples were also

summarized in data tables. Summary tables for analytical data were generated from Envista for each focus area for review of the historical investigation results. Analytes included the following: VOCs, SVOCs, pesticides, PCBs, herbicides in ug/L (water) or ug/kg (solids); metals in mg/L (water) or mg/kg (solid); and tentatively identified compounds (TICs). These data are presented in the appendices.

Soil data were compared to both NJDEP Non-residential direct contact soil cleanup criteria (NRDCSCC) and NJDEP Impact to Groundwater (IGW) criteria. Groundwater data were compared to NJDEP Class IIA Groundwater Quality Criteria (GWIIA). Groundwater data from monitoring wells screened in the B Aquifer was used for the assessment, as described in Section 3.6. Sediment and surface-water results were compared to ecological benchmark as outlined in the BEE (DuPont, 2006).

SWMU 8 FA tables were not resubmitted in this report because they were recently submitted in the SWMU 8 RI Addendum Report (2006). In these cases, the reader is referred back to the original documentation for the complete data sets.

3.7.1 Pathway Analysis

To evaluate the FAs for historical or current sources and receptor media, the data were evaluated from two perspectives.

In one approach, process history and material or waste handling areas were identified along with chemicals used in the area. Potential areas of release or potential source areas were identified. If environmental data were available in the area, they were then reviewed for potential impacts from site activities.

In another approach, environmental data were reviewed first and the spatial distribution of contaminants evaluated. By considering groundwater flow pathways or the location of the soil data, potential sources that may have caused the impact were identified. Both of these approaches were performed in an iterative manner.

An analysis was undertaken by reviewing building maps and aerial photographs to identify process buildings with accessory areas (storage tanks, unloading areas). Then, the chemical database was reviewed for chemicals of interest. Chemicals of interest could be identified based on historical process knowledge obtained from documentation or from interview information. The chemicals of interest were then reviewed for their presence in different media (i.e., soil, surface water, sediment, and groundwater) along physical features such as trenches and ditches. Using the GIS, exceedances in various media were plotted. The goal was to evaluate if any other potentially significant sources were identified.

This analysis is summarized in the pathway analysis discussion for each focus area. Additionally, ditches that may be a potential source area are identified in the focus areas; however, because the ditches are considered on a site-wide scale, they are described in the Section 4.3.1.

3.7.2 Recommended Areas for Additional Investigation

Within each focus area discussion, recommendations for additional investigation are proposed where potential sources were identified. The recommendations are based on the assessment of potential sources and pathway analysis. If no further investigation is necessary, justification is provided.

3.8 Site-Wide Evaluation

Finally, findings from the individual focus areas were integrated into a site-wide conceptual model of known and potential source locations, migration pathways, and receptor media. This integrated evaluation was then used to further define areas for future investigation at the site. The recommended investigations within these areas are also presented. The site-wide evaluation is presented in the next section, and it serves as the culmination of the preliminary assessment of Chambers Works Complex. Subsequent sections provide the detailed analyses conducted for each focus area, followed by a summary of conclusions and recommendations.

4.0 SITE-WIDE EVALUATION

This section presents a discussion of site-wide environmental conditions based on an integration of the focus area (FA) evaluations. Also described in this section is the development and utilization of the Chambers Works GIS. The GIS was the main tool used to integrate data within the FAs, and will be used to accurately identify locations of interest in the field. A detailed historical and analytical data review of the FAs within the context of the site was conducted. As a result, the boundaries that define process areas were refined from the initial FA boundaries into eleven AOCs. These AOCs require additional investigation and general recommendations for additional work are presented.

The purpose of a CSM, generally, is to provide a representation of site conditions that show what is known (or suspected) about contaminant source areas and the physical, chemical, and biological processes of contaminant transport. The CSM for the site in this Preliminary Assessment focused on determining potential source areas and migration pathways to media receptors (i.e., groundwater, surface water and sediment). Because of the intent of this Preliminary Assessment, the updated CSM was not extended to identifying complete exposure pathways to human and ecological receptors.

Based on the evaluation of potential sources and refinement of the CSM, DuPont recommends the following additional investigation:

- Evaluate B Aquifer groundwater quality downgradient of potential sources in areas of the site where insufficient data exists. Assessing groundwater quality in these areas will help to determine whether an area is (or was) a source to groundwater.
- Increase spatial characterization of B Aquifer hydraulic gradients near the site perimeter to confirm hydraulic containment by the IWS.
- Further refine understanding of potential groundwater to surface-water pathways by installing additional perimeter monitoring wells.
- Evaluate soils that may be acting as sources to groundwater by further characterizing the distribution of elevated concentrations.
- Evaluate sediment quality in the vicinity of historical process wastewater outfalls along the Delaware River and Salem Canal.
- Further evaluate soil, sediment and surface water quality in Carneys Point as part of the Ecological Risk Assessment for Carneys Point.
- Refine the location/boundaries of several SWMUs based on review of more accurate aerial photographs and GIS data.

4.1 Objectives

The objectives of the site-wide evaluation are as follows:

- Describe the chemical constituents, sources, and impacted media that are prevalent on a site-wide scale.

- Describe the history and potential impact of a primary on-site source that is present throughout the Chambers Works manufacturing area – the historical ditches and outfalls
- Summarize the findings and recommendations of the individual FA evaluations that are presented in Chapters 5 through 20.
- Based on the results of the FA evaluations, define AOCs wherein additional investigation is recommended.
- Present a revised Conceptual Site Model in tabular form that summarizes the primary constituents of concern, known or suspected media of interest, and the primary historical or current sources in each AOC.
- Summarize the recommended additional investigations within each AOC.

4.2 Site-Wide Constituents

In general, there are two classes of contaminants that are prevalent at the site: organic compounds, including volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs), and metals. The most prevalent are SVOCs.

4.2.1 SVOCs

SVOCs are the most common chemical detected in site soil, groundwater, and sediment. These constituents are mainly associated with the manufacturing of dyes and dye intermediates in the southern portion of the site. Some of the most prevalent SVOCs, in terms of their spatial distribution and concentrations measured in soil, sediment, and in the B Aquifer groundwater, are as follows:

- Chlorobenzene
- Nitrobenzene
- Aniline
- 4-Chloroanaline
- 1,2-Dichlorobenzene
- 1,2,4-Trichlorobenzene

Numerous other SVOCs, and some VOCs such as benzene, are also present but at lower concentrations.

Elevated SVOC concentrations in groundwater are present in the former dyes and intermediates manufacturing areas, in the vicinity of sections of the former process wastewater ditches, at the perimeter of the former basins, and at the western boundary of SWMU 8. Even in areas that did not specifically manufacture dyes or related products, such as the TEL area, SVOCs are present in groundwater. Some wells along portions of Salem Canal and the Delaware River contain elevated concentrations of site-related constituents of concern (COCs), indicating the potential for transport of constituents toward surface water through groundwater discharge. Site-related constituents have also been detected in sediments in the Salem Canal.

Although these SVOCs are ubiquitous across the Chambers Works manufacturing area, in the Carneys Point area, SVOCs are generally not detected in environmental media because these compounds were not used or manufactured in the Carneys Point area (see Figures 3-8 through 3-14b).

4.2.2 Metals

Metals are generally detected across most of the Chambers Works manufacturing area in unfiltered groundwater samples. The most common metals, which also exhibit the highest concentrations, are iron and sodium. Iron and sodium occur naturally in the environment. Other metals present at much lower concentrations include lead, arsenic, aluminum, nickel, mercury, and antimony (for example, see Figures 15a through 16b). These metals were typically used as catalysts for various manufacturing processes.

Metals are not generally detected in the deeper aquifers, and a study is currently underway to further evaluate the potential for vertical migration of metals from the unsaturated zone into the B Aquifer at Carneys Point (Phase IV RFI Supplemental Work Plan, DuPont, 2005).

Lead, in particular, is present at elevated levels in the former TEL manufacturing area, at the perimeter of the Basins FA, and in portions of SWMU 8. The presence of lead at these locations is expected given the manufacturing history and disposal practices. Relative to the SVOCs, lead is very immobile and does not appear to be transported by groundwater, as indicated by the absence of dissolved lead at most locations where total lead is detected above the GWIIA (compare Figure 3-15b and 3-15c[2]). Accordingly, dissolved phase lead is not present in perimeter wells. Therefore, it is unlikely that lead concentrations are migrating from groundwater to surface-water bodies.

4.3 Site-Wide Contaminant Sources

The location(s) of site-related constituents in impacted soils and groundwater may be related, in part, to local features at specific processing, storage, or transport areas. These potential sources are identified in the individual focus area sections. A potential source that is present on a site-wide scale is the historical process wastewater ditch system and associated outfalls. Although these features no longer transport or discharge wastewater and have been remediated under the ACO with NJDEP, migration of site-related constituents during historical operations may have resulted in elevated concentrations in underlying soil and groundwater proximal to the ditch system. This site-wide feature is presented below.

4.3.1 Ditches and Outfalls

Figure 4-1 shows the historical network of process wastewater ditches and outfalls. Minor outfalls to the Salem Canal and Delaware River that have historically discharged only stormwater runoff from roadways and parking areas are not shown. The clustered, relatively short ditch sections represent building floor drains/trenches, sumps, and/or

[2] NJDEP requires comparison of only total groundwater analytical results to GWIIA.

pipes that drained to the main sections of the exterior ditches. All ditch and outfall features were imported from other electronic files if available. Features not available in electronic format were digitized from building maps and site-plan drawings. Ditch and outfall locations created in the GIS were compared to aerial photographs, historic plant layout maps, and other drawings to verify accuracy.

General History

From 1917 through the 1980s, process waste handling at the Deepwater Dye Works (Chambers Works) was through a series of open, lined and unlined ditches. Since 1991, all process wastewater has been conveyed to the on-site wastewater treatment via a system of lined sumps, above ground "regional tanks" and an overhead pipeline. Historically, each production building typically had trenches and/or sumps that collected process wastewater. Process wastewater then flowed into a drainage ditch adjacent to the buildings and combined with process wastewater from other buildings and other waters, including sanitary wastewater, cooling water, stormwater, and steam condensate.

According to interviews with retirees, daily facility cleaning included first washing the buildings and equipment with water or solvents and then channeling the effluent and waste materials to the ditches. Site retirees recalled that ditches were almost always flowing and rarely, if ever, dry.

For buildings at the interior of the site, wastewater entered the nearest ditch and flowed through the network of ditches that ultimately discharged to the wastewater settling basin area at the site interior (see Section 12). The settling basin discharged directly to the Delaware River from 1917 to 1958. The basin was upgraded with an outfall structure and pH adjustment in 1958. Additional upgrades since 1958 include the construction of the WWTP in 1975 and the overhead sewer system in 1991.

For some buildings adjacent to the Delaware River, wastewater entered the nearest ditch and flowed directly to the river through the nearest outfall location. There were up to 15 historical outfalls along the Delaware River and Salem Canal that may have conveyed process wastewater directly off-site prior to discharge permitting requirements in1958[3].

Before 1932, the Salem Canal was a tidal water body connecting the Delaware River to the tidal wetlands of Salem Creek. From 1917 to 1932 wastewater from buildings adjacent to the Salem Canal entered the nearest ditch and flowed to the canal through outfalls, or to the wastewater settling basin at the interior of the site. In 1932 DuPont constructed Munson Dam to isolate the canal from the river. DuPont also reconfigured the ditches adjacent to the canal to prevent process waste from entering the Salem Canal. After 1932, the outfalls to the Salem Canal upstream of Munson Dam discharged stormwater and non-contact cooling water only. Engineering controls have been implemented by DuPont to maintain the water quality in the Salem Canal, as it continues to be the primary potable water source for the Chambers Works.

In 1957, DuPont constructed an outfall structure and treatment system for the wastewater basin in accordance with the Federal Water Pollution Control Act (FWPCA). Wastewater

[3] Since 1991, all process-related wastewater has been conveyed to the on-site WWTP through an integrated system of regional collection tanks and elevated pipelines, thus preventing discharges to the environment.

from the basin was pumped into a surge tank and treated with lime to adjust the pH prior to discharge into the Delaware River via the permitted outfall structure 001.

Between 1958 and 1975, process waste outfalls were plugged, and the wastewater was diverted to the wastewater basin via the ditches. During this period process wastewater discharged to the Delaware River through permitted outfall 001 after settling of solids in the basins and pH adjustment. Other outfalls became permitted and continued to be used for stormwater/non-contact cooling water discharge.

In 1972, DuPont reconfigured the basin and ditch system at the Chambers Works and began construction of the WWTP in accordance with the Clean Water Act. As described in more detail in Section 12, the Basins FA was separated into three basins: A Basin, B Basin, and C Basin. In 1974, the ditch system associated with the TEL manufacturing area was diverted to flow into the C Basin, which was constructed as a settling and pre-treatment basin for TEL process wastewater prior to discharge to the A Basin and subsequent treatment in the wastewater treatment plant.

In 1975, the ditch system from the remainder of the plant was further separated to form "A Ditch" and "B Ditch." Process wastewater was discharged through the A Ditch to the A Basin and then to the WWTP. Some portions of the former process waste ditches were used for stormwater/non-contact cooling water and designated as B Ditch, discharging to the B Basin. The A Ditch and B Ditch were later designated SWMU 17 and SWMUs 56/56A, respectively (see Figure 4-2). The location of ditches (SWMUs 17, 56, 56A), shown in Figure 4-1, is based on as-built drawings and verified in the field during remediation. These field-verified locations of the ditches from the GIS differ from the hand-drawn approximations of the ditch system layout in the early 1990s. A modified map of SWMU 17 and SWMU 56A that more accurately reflects the locations is planned to be submitted in 2007.

In November 1988 (prior to 11/8/88), as required by regulations, discharge of treated wastewater to the B Basin was discontinued. Treated wastewater went directly to the collection tank where it was combined with B Basin non-contact cooling water and stormwater prior to being discharged to the Delaware River through the permitted NJPDES outfall.

Remediation of Ditches

In 1991, the unlined A Ditch was replaced with a 1,300-foot overhead piping system that remains in use. From 1993 through 1996, a large-scale program was initiated to remediate the network of unlined, exterior ditches. Ditch material was removed from the bottom of all ditch sections down to the groundwater table as required by the NJDEP. The sidewalls of the ditch section were sampled approximately 1 foot from the edge of the ditch and analyzed for specific target constituents. In addition, one sample from each ditch section was sampled for Appendix IX parameters and tentatively identified compounds. In areas where sidewall sample concentrations exceeded the A Ditch sidewall soil clean-up criteria, delineation samples were collected 25 feet on either side of the initial sample. Any area of sidewall soil that had constituent concentrations greater than the soil cleanup criteria was removed to a maximum distance of one foot from the side of the ditch.

SWMU 17 was replaced with a system of pipes and asphalt swales. The replacement system is currently used for collection and conveyance of noncontact cooling water, stormwater runoff, and steam condensate to the B Basin. Once the replacement system was installed, the excavated ditch was brought to grade with clean fill and covered with at least 3 inches of gravel.

Figure 4-1 shows the portions of the ditch system where ditch material was removed in compliance with ACO (indicated in green), and those where no removal was required under the ACO (indicated in magenta). Note that most of the relatively short sections shown in magenta are building trenches/pipes rather than open and unlined ditches. As shown in the figure, the majority of the main sections of exterior ditches were remediated, except for the main ditch sections emanating from the Fluoroproducts FA. These sections were not remediated, in part, because sampling of the ditch sediment at some locations showed minimal concentrations of site-related constituents.

Discussion

Some of the post-excavation samples from subsoils beneath remediated ditches and sidewall samples adjacent to ditches contained constituent concentrations above applicable screening levels. Therefore, it is uncertain whether the soils are acting as significant sources of dissolved phase constituents to the B Aquifer groundwater.

DNAPL has been detected in only a few locations across the site. DNAPL is recovered at SWMU 63 along the Salem Canal and in the northeast portion of SWMU 8. However, uncertainty exists at major portions of the ditch system in the Dyes and intermediate areas where chlorinated solvents were used in manufacturing. Evaluation of groundwater data in several monitoring wells near the main section of the PWDS (SWMU 17) indicate the presence of organic compounds between 1% and 10% of total aqueous solubility, which suggests DNAPL is potentially present. Based on this evaluation, additional investigation is recommended in the area of the ditches.

In addition to major ditch segments, elevated concentrations of site-related constituents may be associated with clustered networks of lined trenches in certain process areas. Based on observations made during the extensive ditch remediation program, drains that lead from the building interior to the exterior ditch were mainly constructed of metal pipes, wooden culverts, or concrete-lined culverts. The integrity of these lined trenches is uncertain. Therefore, site-related constituents may also be present in soils near and beneath the clustered network of the relatively short trench segments shown in Figure 4-1.

4.3.2 Groundwater as a Contaminant Source

Groundwater is defined as an environmental receptor by NJDEP. However, because migration of groundwater containing site constituents can potentially impact surface water and sediment, groundwater at the site is itself a potential source. In 1970, DuPont constructed the IWS to capture groundwater and to help prevent off-site migration of groundwater containing site constituents. The IWS has been in continual operation for 36

years, thus maintaining groundwater containment across a majority of the site[4] and removing site constituents from groundwater through the WWTP. Based on an average flow of 1.5 million gallons per day, and analysis of groundwater quality from the IWS wells, the IWS recovers over 200 pounds per day of organic constituents (e.g., ODCB, chlorobenzene, aniline, nitrobenzene, benzene, etc.).

4.4 Site-Wide Media of Interest

4.4.1 Surface Water

Surface-water features in the vicinity of the site include the Delaware River, Salem Canal, Bouttown Creek, and Henby Creek. The potential migration pathways to these media include surface runoff, interaction between surface water and groundwater (i.e., discharge of groundwater to surface water), and discharges from the historical outfalls.

4.4.2 Groundwater

Because the B Aquifer is the shallowest aquifer beneath the site, it is the first aquifer affected by releases. Therefore, analytical data for the B Aquifer was used for this PA, as described in Section 3. Deeper C and D Aquifers contain site-related constituents above GWIIA criteria (but at much lower concentrations than in the B Aquifer) typically near discontinuities in the B/C confining unit and at interceptor wells. The IWS hydraulically contains C and D Aquifer groundwater on-site. These aquifers will be evaluated further as the long-term comprehensive remedial approach moves forward.

In the deeper E Aquifer, one on-site well, N08-M01E (see Figure 2-3), has relatively low concentrations of some site-related constituents. However, as described in the E Aquifer Evaluation as part of the Phase IV RFI (DuPont, 2005), this is believed to be caused by a faulty well casing as based on cement bond logging. Well N08-M01E was to be properly abandoned by a licensed driller in the spring 2006.

4.4.3 Sediment

Sediment in the vicinity of the site includes Salem Canal sediment, Bouttown Creek and Henby Creek sediment, and Delaware River sediment. Sediment samples have been collected in the Delaware River as part of the SWMU 5 and SWMU 52 pre-design investigations. Organic constituents common to the site were present in SWMU 5 sediment samples. Arsenic and lead associated with the site were detected in sediments adjacent to SWMU 52. Sampling results from the Bouttown Creek and Henby Creek in Carneys Point detected metals. Sediment sampling in Salem Canal in the vicinity of SWMU 63 and analysis of recovered DNAPL revealed elevated concentrations of dye-related organic constituents.

[4] Shallow groundwater along the western portion of the site near the Delaware River flows towards the river. This component of groundwater flow is not believed to result in constituent concentrations being discharged to the river above ambient water quality criteria based on modeling. However, additional investigation is currently being performed to further evaluate this flow path.

Sediment investigation and a remedial alternatives analysis is underway at Salem Canal. Additional assessment of sediment in Carneys Point will be conducted under the ecological risk assessment. Sediment sampling is planned in the Delaware River in the vicinity of the historical process wastewater outfalls. This sampling will be performed as part of the Perimeter Investigation that will follow this PAR.

4.5 Areas of Concern (AOCs) and Recommended Investigations

As described in Section 3, the assessment of potential sources and receptor media described in this report was performed in a step-wise approach, the methodology and findings of which are as follows:

- Based on an initial understanding of the site history, the site was subdivided into 16 FAs that roughly defined areas with similar histories such as manufacturing processes and waste disposal practices. Based on additional research, sub-areas were defined within some FAs, as shown in Figure 4-2.
- Aerial photographs, site maps, process history, and analytical data were analyzed to identify potential sources and receptor media, and make recommendations of areas for further investigation. As shown in Figure 4-3, DuPont recommends additional investigations across most of the site. It should be noted that for those areas that are currently being investigated or where remedial measures are underway, additional investigation was not recommended based on the findings of this PAR. For example, SWMU 8 is not designated for additional investigations because characterization is complete and a Corrective Measures Study is underway. Carneys Point also was not designated for additional investigation in this PAR because investigations are ongoing or will be performed as part of a separate ecological investigation.
- As a result of the detailed historical and analytical data review performed as part of this PAR, the boundaries that define different process areas were refined from the initial FA boundaries. Based on this refinement, and on areas at the site that require additional investigation, 11 AOCs were defined, as listed below and shown in Figure 4-4:
    - AOC 1: Fluoroproducts
    - AOC 2: TEL
    - AOC 3: Jackson Labs
    - AOC 4: Aramids
    - AOC 5: Historical Basin Footprint and Ditches
    - AOC 6: Dyes
    - AOC 7: Elastomers
    - AOC 8: Warehouse, Transport and Construction
    - AOC 9: Monastral
    - AOC 10: White Products
    - AOC 11: Former Drainage Ditch

In addition, Delaware River sediments that may have site-related constituents associated with former outfalls are included in the AOC table in Figure 4-4, and sampling of these sediments is recommended.

The table in Figure 4-4 summarizes the updated conceptual site model, as described in Section 4.6, and provides the recommended investigations within each AOC. Specifics regarding the number and locations of sampling and monitoring points are not presented in this PAR. Following receipt and incorporation of agency comments on this PAR, a work plan for additional investigations associated with the site perimeter will be submitted, followed by a work plan for additional investigations associated with the interior of the site.

Recommendations

Additional investigation is recommended in each AOC. In general, additional sampling is proposed to meet the following objectives:

- Evaluate B Aquifer groundwater quality downgradient of potential sources in areas of the site where insufficient data exists. Assessing groundwater quality in these areas will help to determine whether an area is (or was) a source to groundwater. Example sources include the following:
  - Former process wastewater ditches
  - Major loading and unloading areas
  - Areas of waste disposal
  - Suspected areas of residual NAPL or DNAPL accumulations
- Increase spatial characterization of B Aquifer hydraulic gradients near the site perimeter to confirm hydraulic containment by the IWS.
- Further refine understanding of potential groundwater to surface-water pathways by installing additional perimeter monitoring wells.
- Evaluate soils that may be acting as sources to groundwater by further characterizing the distribution of elevated concentrations.
- Evaluate sediment quality in the vicinity of historical process wastewater outfalls along the Delaware River and Salem Canal.
- Further evaluate soil, sediment and surface water quality in Carneys Point as part of the Ecological Risk Assessment for Carneys Point.
- Refine the location/boundaries of several SWMUs based on review of more accurate aerial photographs and GIS data.

4.6 Updated Conceptual Site Model

A CSM is a representation of site conditions, including what is known or suspected about the contaminant source area(s) and the physical, chemical, and biological processes that affect the transport of contaminants through environmental media to potential environmental receptors. The CSM for the site focused on determining potential source areas and migration pathway to media receptors (i.e., groundwater, surface water, and

sediment). Because of the purpose of the Preliminary Assessment (PA), the CSM was not expanded to identifying complete exposure pathways for human and ecological receptors.

The Chambers Works CSM has been updated based on the findings of this PA. The updated CSM is similar to the previous CSM, but more distinct potential sources have been identified.

The CSM can be summarized as follows: site-related constituents, mainly organic chemicals such as chlorobenzene, 1,2-dichorobenzene, aniline, nitrobenzene, benzene, and other SVOCs and VOCs related to the manufacturing of dyes, dye intermediates, and elastomers, are present at elevated concentrations in groundwater across the Chambers Works manufacturing area (south of the Carneys Point area). The distribution of site-related constituents is the result of several factors:

- The size of the historical manufacturing area,
- The fact that the manufacturing and use of these organic chemicals were not building-specific but rather changed from building to building over time,
- Releases of chemicals to soil at discrete locations such as a loading/unloading areas, miscellaneous releases near process buildings, and on a larger scale, from the network of earthen process wastewater ditches that transported liquid waste from the manufacturing areas to the basins.

The presence of organic chemicals in groundwater across much of the Chambers Works manufacturing area is due to (1) the use of these chemicals in manufacturing or as solvents and (2) the transport of groundwater caused by large-scale pumping of the IWS since 1972.

Because of these factors, it is impossible to identify all locations where subsurface soil or DNAPL is contributing to elevated levels of constituents in groundwater.

In some cases, chemicals that are specific to particular products are present mainly in those areas where they were produced. For example, carbon tetrachloride is used in the production of flouroproducts and the highest groundwater concentrations are present in that manufacturing area (see Figure 3-13b). Lead is another example: it is present in soil and groundwater mainly in the former tetraethyl lead manufacturing area (see Figure 3-15b). The very low mobility of lead in groundwater is another reason why it is concentrated in this area.

Historically, some process wastewater discharged from the ditches directly to the Delaware River and Salem Canal via outfalls. Hence, sediment may contain site-related constituents near these locations.

The above discussion outlined the CSM that was defined prior to the PA. All of the elements still hold. The primary updates based on the PA are described below.

Additional potential sources and source areas have been identified. These include, for example, soil present beneath clean fill south of the Basins FA and the location of a 100,000-pound discharge of ortho-chloronitrobenzene near the central portion of the manufacturing area (which occurred in the 1980s). Details regarding these and other sources are described in the FA sections. An updated CSM is summarized in tabular

format in Figure 4-4 and includes potential sources, potential migration pathways, and media of interest.

A significant aspect of this PA effort is the precision of the CSM that has been established as a result of the GIS system. For example, although contaminant sources already were considered more likely in manufacturing areas with higher production rates, specific locations within the manufacturing areas have been identified precisely by digitizing site maps and aerial photographs. Further, these locations can now be identified accurately in the field. This upgrade will facilitate confirmation of potential sources, such as ditches, by sampling at precise locations. Similarly, the locations of historical outfalls have been mapped and will therefore be used as the basis to define the sediment investigation program as part of the perimeter investigation.

DuPont will continue to update the GIS system by incorporating the results of additional investigations as they are performed. Likewise, the CSM will be refined and will be an excellent tool to help manage and direct future remedial actions.

5.0 FOCUS AREA – WHITE PRODUCTS

Evaluation of the White Products FA indicates that further investigation is recommended near Ponsol #2 (Building 770) and White Products North Bulk Storage area (north of Buildings 149, 152, 788). The proposed investigations are based on the evaluation of historical process data, aerial photographs, site maps, analytical results of soil, sediment, and groundwater sampling, and on a pathway analysis. The review and analyses were conducted consistent with applicable regulations and guidelines.

The Ponsol #2 Building trench is an area of interest because solvents (e.g., anthraquinone, chlorobenzene, aniline) were used extensively in the production of Ponsol dyes in this building, and wastes were washed into the building trench and out to the process wastewater ditches. Groundwater sampling in the vicinity of these and other former ditches is recommended to assess these features as potential sources of groundwater contamination.

The Borneol House (Building 148) trenches and drainage are of interest because turpentine and other raw materials may have been released to ditches and/or to a former outfall into the Salem Canal. Sediment has not been sampled at that discharge location. Therefore, evaluation of ditches is recommended, as well as sediment sampling in the Salem Canal at the former outfall locations.

The White Products North Bulk Storage area was long used for chemical storage, and releases may have occurred in former loading, and unloading areas to the north of Buildings 149, 152, and 788. Compounds of interest, including 1,2-DCB and chloroaniline, have been detected in shallow groundwater south of former Buildings 149/152.

There are currently no monitoring wells in the northwestern portion of this FA, which is downgradient of the Bulk Storage area and downgradient of a north-south trending ditch that drained the former Dyes manufacturing area. Therefore, groundwater sampling is recommended in this area to assess these features as potential sources to groundwater.

The full evaluation is presented in the rest of this section. Details about the recommended investigations, such as number and location of monitoring wells, sampling points, and sampling methodology, will be presented in subsequent work plans.

5.1 Areas of Interest

The White Products FA encompasses about 20 acres in the southernmost section of the site and in the south-southeastern portion of the former Dye Works (see Figure 5-1). The White Products FA is bounded by the Salem Canal to the south, Broadway Road and the Triangle FA to the north, Shinn Road and the Pharmaceutical FA to the east, and Garage Road and the Dyes FA to the west.

Several SWMUs are located within the White Products FA and have been investigated or remediated as part of the Chambers Works RFI program. These areas are shown in Figure 5-2 and are discussed in the History section (see Section 5.2), but they do not require additional evaluation as part of the pathway analysis:

- SWMU 10: Solvent Recovery Unit II
- SWMU 38: Clean Water Injection Well J05-W01E
- SWMU 41-5: Drum Storage Area

The following areas of interest are subject to pathway analysis to determine if additional investigations are necessary:

- Former Ponsol #2 (Building 770): Western Side of Building Loading Area and Interior Building Trench
- Borneol (also known as Bornidol) House Trench and Ditch (Building 148)
- White Products North Bulk Storage Area (north of Buildings 149, 152, 788)

These areas are shown in Figure 5-3.

Based on common processes, history, chemical use, and disposal practices, the White Products FA has been subdivided into two distinct areas (Figure 5-1):

- Southern side: Synthetic Camphor/White Products area included four buildings, used in the early years for the production of synthetic camphor, which were taken over for White Products. White Products used three main buildings in the area, and one is still in use (Building 788).
- Northern side: Ponsol Colors area consisted of one main manufacturing building (770) and one warehouse (588). Two supporting buildings, the Ponsol office and change house, and a laboratory were located across Broadway Road.

As seen in Figure 5-2, White Products Road divides these two areas.

5.2 History

The White Products area started in 1917 with the production of synthetic camphor. In the 1930s, production of various detergents and textile protectants began and continues to the present day. In 1936, DuPont built the Ponsol #2 building (Building 770) north of the detergent/protectant manufacturing area for the production of Ponsol colors. Ponsol color production was discontinued in 1980s when DuPont sold the dye business. The former Ponsol Colors area is now a parking lot.

5.2.1 Synthetic Camphor and Current White Products Area

Before 1917, the White Products FA was open land and bordered on a road (Canal Road) to the residential community known as Fenton's Beach. Initial construction of the Deepwater Dye Works began in the 1917 with the construction of the Synthetic Camphor buildings. A plant (consisting of four buildings) was built at the Dye Works on the site of the existing White Products operations (Synthetic Camphor and current White Products area). Synthetic camphor was manufactured from 1918 to about 1922. The compounds

used in the production of camphor included the following: acetone, sulfuric acid, caustic soda (sodium hydroxide), chlorine, hydrochloric acid, sulfur dioxide, sperm oil, peanut oil, cocoa nut oil, anhydrous isopropanol, and bulk ammonia. A typical off-gas from the methylol stearamide process was formaldehyde fumes (DuPont, 1978). After the camphor operations ceased, several of the buildings built for camphor production were later converted for use by White Products operations.

In the early 1930s, DuPont acquired the Newport Chemical Cosynthetic camphor process and moved operations into a building originally used for the manufacture of TEL and ethyl chloride. This newly developed process started production in 1932 and continued until 1959. Camphor manufacturing went online with a rated capacity of 1.5 million pounds per year (DuPont, 1978). By adding extra manufacturing equipment, production increased to 2.5 million pounds in 1936. The peak production for camphor was 9 million pounds/year in 1944.

In 1949, the process catalyst was changed and camphene was produced in tablet form. In 1950, DuPont installed equipment for this "Zeset" S (Dimethylolethyleneurea) production. The "Zeset" family of products are used in the textile industry for the coating of various fibers and was sold commercially. The material was used to "cross-link" cellulose to impart crease resistance. In 1955, the camphene tablet line was discontinued, and the equipment was sold. In 1959, DuPont discontinued manufacturing of camphene.

The following buildings were used to manufacture camphor:

- ❑ Old Camphor Building/Gardinol Building (147): This building operated from 1918 to 1922 and was idle from 1922 to 1932. In 1932, the building was revamped for production and converted to camphene production in 1934.
- ❑ Acetyl Building (149): This building completed sulfation of imported Lorol fatty alcohol with chlorosulfonic acid.
- ❑ Camphene Building (152): Building processes are not currently known.
- ❑ Building 788 (or “A” Building): Construction of this building started in early 1937. This building produced accelerator No. 522, “Aridex” white products, WPX.HW and MR-41 DuPont Plant Spray, “Duponol” MEAW, Retarder W and “Zwinte” A. In 1938, alcohol purification was added to building processes and dipentamethylenethiuram tetrasulfide (“Tetrone” A) was produced.
- ❑ Old Borneol House: This building was also referred to as Bordinol (148) and was demolished in 1946.
- ❑ MP-Plant (189): This building was constructed in 1947 and 1948, and was idle in 1949.

No data are available for camphor waste disposal practices. Based on disposal practices ascertained from the Dyes FA (see Section 6), it can be assumed that any wastewater produced was most likely released to the closest ditch system. As discussed in Section 4.3.1, process wastewater from buildings adjacent to the Salem Canal may have discharged directly to the canal prior to 1932, at which time the canal became the primary freshwater water supply for the plant.

5.2.2 Current White Products Area

In addition to producing camphor, in 1932 DuPont formed a corporation with Proctor and Gamble (Gardinol Corporation, later renamed Duponol). The Gardinol Corporation manufactured higher alcohols and sulfates for detergents. From 1932 to present, the White Products FA has made a variety of compounds, including detergents, textile finishing agents, water repellents, rubber chemicals, and petroleum chemicals.

Currently, Building 788 (the "A" Building) is the main building for producing protectant chemicals used for treating textiles and nonwoven materials. Approximately 40 products are produced, most of which use several different monomers, with the main ingredients being either ZFAN or ZFM. (Those ingredients are currently produced in the Chambers Works Zonyl® Intermediates Building.)

Based on a process database review, Buildings 149 and 152 were used to produce compounds similar to those in Building 788 (e.g., Zelec®, liquid surfactants). These buildings were demolished in the late 1980s.

Since 1991, the process wastewater from the White Products "A," "B," and "D" buildings is pumped to regional collection tanks and then to the on-site WWTP by overhead pipeline.

5.2.3 Ponsol Colors

The Ponsol Colors area primarily produced vat colors and their precursor intermediates from February 1919 until about 1980 when DuPont sold the dyes business. Ponsol Colors was a DuPont trade name for vat colors containing the anthraquinone nucleus; however, early dye history refers to these dyes as anthracene colors. Vat colors are a class of insoluble dyes that are suitable to impregnate into textile fibers. The dyes produced in the Ponsol Color area included "Ponsols," "Leucosols," "Lithosols," "Sulfanthrenes," "Potamines," Celanthrenes," DuPont Anthraquinone colors, and "Latyls" dyes.

The vat colors made in the Ponsol Colors area were developed from a basic chemical building block, the anthraquinone nucleus. Anthraquinone was originally made at the Dye Works from anthracene (coal tars) and later from phthalic anhydride. In 1936 to 1980, Ponsol Colors production was consolidated into the Ponsol #2 Building (770). The Ponsol #2 Building housed intermediates, colors, and standardization sections, and was expanded in 1939, 1941, and 1952 for increased production. The Ponsol #2 Building was razed in the early 1990s.

Based on Chambers Works documentation dating from 1919 to 1958, dye production from 1922 to 1927 ranged from 1 million to 3.6 million pounds per year. In 1939, production was approximately 37.5 million pounds per year. These production numbers increased from 1939 until 1944, reaching approximately 77.8 million pounds per year. Ponsol Colors production then declined through the late 1940s into the 1950s to approximately 51 million pounds per year. No production statistics for the Ponsol Colors manufacturing area are available for the 1960s and 1970s. In January 1980, DuPont announced the sale of 80% of its dye business, and dye manufacturing at Chambers Works continued only to the end of 1980.

Based on interviews with retired plant personnel, the waste from the Ponsol #2 Building was released to the existing floor drains, which connected to the existing site ditch system. In addition, the building foundation or trench was not removed when the building was razed. The Ponsol #2 Building foundation was covered with gravel, and in 2005 was covered with an asphalt parking lot. Because the trenches were concrete lined, they are not considered to be a significant historical source for soil contamination.

5.3 Previous Investigations

The SWMUs identified as part of the RFI within the White Products FA are shown in Figure 5-2 and are discussed here. More detailed descriptions of these SWMUs were submitted in January 2002, in the report titled *Chambers Works FACT Sheets* (DuPont, 2002).

5.3.1 SWMU 10 (Solvent Recovery Unit II)

SWMU 10 recovered chlorinated solvents such as chlorobenzene and 1,2-dichlorobenzene (ODBC) in association with the dye manufacturing area including the Ponsol Colors area. The SWMU is approximately 700 square feet and was sampled as part of the Phase I RFI. Samples for soil were analyzed for the following chlorinated solvents: benzene; chlorobenzene; 1,2-dichlorobenzene (ODCB); 1,3-DCB; and 1,4-DCB. No constituents were detected in the samples. This area is currently paved and used for truck parking. Based on these sample results, no further remedial activities were warranted for SWMU 10. An NFA and Covenant Not to Sue was issued by the NJDEP on October 24, 2002 for SWMU 10; therefore, no additional work is proposed for SWMU 10. This SWMU was not retained as needing further evaluation.

5.3.2 SWMU 38 (Clean Water Injection Well J05-W01E)

The site has several clean water injection wells that historically were used for injecting potable water into the deep aquifer unit for storage during times of drought. One of these wells, J05-W01E, is located in the southern area of SWMU 45-1. This well was not used for waste disposal. Based on a downhole video survey, the wells are in good structural condition. In a letter dated March 25, 1993, EPA agreed that NFA is required. Therefore, no further investigation is needed in this area.

5.3.3 SWMU 41-5 (Drum Storage Area)

This SWMU is a drum storage area that was used to store raw materials, finished products, and waste materials associated with manufacturing processes. The area is approximately 3.5 acres and was sampled as part of the Phase I RFI. Investigation results for soil indicated that all metal concentrations with applicable criteria were below the NRDCSCC. No volatile or semi-volatile constituents were detected. This area is currently paved and is used for parking trucks. An NFA and Covenant Not to Sue was issued by the NJDEP for SWMU 41-5 on October 24, 2002; therefore, no additional work is proposed for SWMU 41-5. This SWMU was not retained as needing further evaluation.

5.3.4 SWMU 17 and SWMU 56A

Sections of SWMU 17 are located within the White Products FA. Details about this SWMU are presented in Section 4.3.1. The sections of SWMU 17 (Process Water Ditch System) within this FA were remediated in the early 1990s and replaced with pipes that are currently used to convey stormwater and non-contact cooling water.

5.4 Pathway Analysis

The following pathway analysis was performed in accordance with the methodology described in Section 3.7.1. For the White Products FA, a number of areas were identified for further evaluation. This conclusion was based on the historical area review, aerial photograph evaluation, review of existing data from various media, review of historical investigations, and review of existing remedial documentation. This section provides the information that was collected and discusses the evaluation that was conducted.

This pathway analysis used, to the extent possible, the existing environmental data in accordance with the NJDEP Technical Requirements. Relevant tables are provided in the CD in Appendix D.

- Chemical Process Database: The chemical process database was queried for the buildings that exist or existed in this focus area and is provided in Appendix D.
- Buildings, Trenches, and Utilities Review: The GIS Building layer, Ditches/Trenches/Outfalls layer, and the Utilities layer were reviewed for this focus area.
- Soil Data: Soil analytical data for this focus area are provided in the tables in Appendix D. Sampling locations and associated chlorobenzene (mg/kg) are shown in Figure 5-4. Figure 5-5 shows chlorobenzene concentrations vs. NJDEP IGW criteria.
- Sediment Data: Sediment is not present in this focus area.
- Surface-Water Data: Surface water is not present in this focus area.
- Groundwater Data: Groundwater analytical data for this focus area are provided in the tables in Appendix D for VOCs, SVOCs, pesticides, herbicides, metals, and TICs for the active B Aquifer wells. Appendix D also provides data tables for the abandoned wells formerly located within the White Products FA. Active and abandoned well locations are shown in Figure 5-6. A total of 15 samples were evaluated: 12 sets from J05-M02B, one set from I05-M01B (installed December 2005), and two sets from J07-M01B.

  In compliance with the NJPDES-DGW Permit No. NJ0083429, groundwater quality in site perimeter wells is monitored. The wells in this program in proximity to this focus area are shown in Figure 5-6. Monitoring well J05-M02B is monitored as part of the DGW program.

  The shallow groundwater flow (see Figure 5-6) in the White Products FA is likely split due to the presence of the Salem Canal to the south. A small portion of the

shallow groundwater flow may flow south toward Salem Canal during conditions when the canal water level is lower than the surrounding B Aquifer (gaining conditions), and away from the canal when the canal water level is higher than the surrounding B Aquifer (losing conditions). The remainder of groundwater flows under the area to the northeast and toward the IWS pumping wells.

A primary manufacturing component at the site was chlorobenzene, and this compound was most commonly detected in the soil and groundwater samples. Therefore, chlorobenzene is used to illustrate the contaminant distribution. Analytical data for all constituents in soil and groundwater were reviewed along with chlorobenzene and are presented in Appendix D.

5.4.1 Ponsol #2 Building (770): Western Side of Building Loading Area and Interior Building Trench

The Ponsol #2 Building trench is considered a potential area of interest based on process and waste disposal knowledge. Many chemicals used in the production of Ponsol dyes were solvents (e.g., anthraquinone, chlorobenzene, aniline), and these solvents were used extensively in this building. The waste disposal practices in the early years involved washing wastes into the building trench and out to the ditches that ran to the basins.

The western side of the Ponsol #2 area was associated with storage, loading, and unloading of materials for use in the Ponsol #2 Building. Additionally, a process water ditch ran north-south in this area and connected to the building trenches. No soil samples have been collected in this area. In shallow groundwater from monitoring well J07-M01B (just to the north of the building and near the associated trench and ditch features), compounds of interest including chlorobenzene, carbon tetrachloride, 1,2,4-trichlorobenzene, and aniline have been detected above GWIIA.

5.4.2 Borneol House Trenches and Drainage

The Borneol House (Building 148) trenches and drainage are considered a potential area of interest based on the lack of process and waste disposal knowledge. Process wastewater containing turpentine and other raw materials entered process waste ditches and may have discharged to the Salem Canal prior to 1932. Process wastewater discharged after 1932 was conveyed to the wastewater settling basin at the site interior.

In the shallow groundwater at a nearby well (I05-M01B), compounds of interest have been detected, including ethylbenzene, xylenes, naphthalene, and 1-naphthylamine. The sediment in the Salem Canal has not been sampled at the location of the discharge from the former trench/ditch that passed just north of the former Bornidol House. Additional sampling of Salem Canal sediment is planned for early 2007 as part of the Salem Canal Seep investigation.

5.4.3 White Products North Bulk Storage

The White Products North Bulk Storage area is considered a potential area of interest based on the long use of the area for chemical storage. Releases may have occurred in former storage, loading, and unloading areas to the north of White Products Buildings

149, 152, and 788. Compounds of interest, including 1,1-DCE, 1,2-DCB, cis-1,2-DCE, 4-chloroaniline, and diethyl phthalate, have been detected in shallow groundwater from well I05-M01B (south of former Buildings 149/152).

5.5 Summary of Recommendations

Based on the pathway analysis, the following is recommended for the White Products FA:

- Collect groundwater samples in the vicinity of the North Bulk Storage area to evaluate the potential effects on groundwater quality.
- Collect groundwater samples in the western portion of the Ponsol Colors area because there are currently insufficient analytical data to characterize groundwater quality in this area.
- Collect groundwater samples in the vicinity of the process wastewater ditches and process building trenches in the Ponsol #2 building area to assess groundwater quality and potential presence of DNAPL.
- Evaluate sediment quality in the vicinity of the historical process wastewater outfalls along the Salem Canal. The sampling will be performed as part of the perimeter investigation.

Groundwater samples may be collected from wells that are currently not used for sampling purposes, where present, or by installing additional monitoring wells, for example. Details about the recommended investigations, such as the number and location of monitoring wells, sampling locations, and sampling methodologies, will be presented in subsequent work plans.

Areas recommended for investigation are shown in Figure 5-7.

6.0 FOCUS AREA – DYES

Evaluation of the Dyes FA indicates that further investigation is warranted throughout the FA except in the Administration and Carpentry Shop areas. The recommended investigations are based on the evaluation of historical process data, aerial photographs, site maps, analytical results of soil, sediment, and groundwater sampling, and on a pathway analysis. The review and analyses were conducted consistent with applicable regulations and guidelines.

The compounds detected in soil, sediment, and groundwater samples in the Dyes FA are consistent with the chemicals used in the dye processes and at the site in general. In the areas of SWMU 63 and the Salem Canal seep investigation, groundwater samples have elevated SVOC concentration, and DNAPL is present in three wells in the southern portion of the FA.

The FA borders the Salem Canal, and elevated levels of site-related constituents in sediment have been detected in one section of the canal. Additional sediment sampling in the vicinity of former process wastewater outfalls is recommended in order to evaluate the potential impact of legacy discharges.

There are few soil and groundwater sampling locations throughout the Dyes FA. Given the elevated constituent concentrations at those locations where samples were collected, the presence of DNAPL, and the fact that some dyes were produced in multiple areas, it is possible that areas of the former wastewater ditches and building trenches are potential current contaminant sources. Therefore, DuPont recommends collecting groundwater samples in the vicinity of the process wastewater ditches to evaluate groundwater quality and the presence of DNAPL. Additionally, installing monitoring well(s) in the northern portion of the FA is recommended since the spatial extent of characterization of groundwater quality cannot be defined with the current distribution of monitoring wells.

The full evaluation is presented in the rest of this section. Details about the recommended investigations, such as number and location of monitoring wells, sampling points, and sampling methodology, will be presented in subsequent work plans.

6.1 Areas of Interest

The Dyes FA encompasses about 39 acres in the south-central portion of the Chambers Works Complex along the Salem Canal. It is bounded by the Triangle FA to the north, the Jackson Laboratory (Jackson Labs) FA to the west, the Salem Canal to the south, and White Products FA to the east (see Figure 6-1).

Ten areas are pertinent to the Dyes FA history, as shown in Figure 6-2. Included are two SWMUs where remedial measures are completed (see *Chambers Works FACT Sheet*, DuPont, 2002):

- ❑ SWMU 41-3: Drum Storage Area
- ❑ SWMU 9: Solvent Recovery Unit 1

A potential pathway analysis was not completed for these areas as part of this PAR. In addition, the Administration area and Carpentry area are not considered for further evaluation in the pathway analysis because these areas have served as non-production areas since dye production began in 1917.

The remaining historical areas are subject to pathway analysis to determine if additional investigations are necessary:

- Sulfuric Acid Plant Area
- Naphthalene Intermediate Area (including SWMU 63: Azo Dye Area)
- Basic Colors and Sulfur Colors Areas (two areas)
- Azo Colors Area
- Ponsol Colors Area

Because the processes were not building specific, the process area was combined into one area for evaluation.

6.2 History

The majority of dye and intermediate compound production, from the beginning of the DuPont company involvement with the dyestuff industry in 1917 until it left the industry in 1980, occurred in the Dyes FA. In fact, this area was responsible for the majority of dye production in the United States, with hundreds of different brand name dyes and an uncountable number of different intermediary compounds being produced. In addition to producing products for market, research and development at the Jackson Labs, and other product-specific laboratories, the Dyes FA also contributed to the development of fluoroproducts (e.g., Freon), tetraethyl lead (TEL), and elastomer products (e.g., "Neoprene" and "Viton"), among others.

This section summarizes the history of the Dyes FA. A more comprehensive history is provided in the in the report titled *Chambers Works History* (DuPont, 1978).

6.2.1 Initial Dye Manufacturing

In the summer of 1915, Dr. A. Chambers was working to develop sources of toluene for DuPont and suggested that DuPont look into the manufacture of a number of dye intermediates, the idea being that these products would be sold to companies already in the dye manufacturing from coal-tar derivatives. In 1916, DuPont purchased from Levinstein Ltd. their completed information on the manufacture of coal-tar dyes and intermediates and embarked DuPont in the dyes business.

Before 1917, the Dyes FA was open land and bordered on a road (Canal Road) to the residential community known as Fenton's Beach. Initial construction of the Deepwater Dyes Works began in 1916-1917. A plant for the production of chlorine and caustic soda by electrolysis of salt was erected southeast of the Deepwater pier (near the center of the TEL FA) and was intended for dual service to the Carneys Point Powder Works and the projected Dye Works operations. Also erected near the Chlorine building was the Sodium Plant and Phenylglycine Building to provide intermediates for the Indigo Factory. In the

Dye FA, other construction projects were started almost simultaneously and included manufacturing facilities for various intermediates and the three main types of dyes (azo, basic, and sulfur colors).

In the spring of 1917, using processes developed at Eastern Laboratory, Gibbstown, New Jersey, some equipment in the picric acid buildings (see Fluoroproducts FA) were adapted to make the first dye at Chambers Works, sulfur black. Sulfur black dye was made from picric acid, dinitrophenol and polysulfide. Four other dyes produced later in 1917 included auramine, indigo, azo, and sulfur colors.

A listing of all of the known buildings is included in Appendix F. Figure 6-2 shows the buildings that were present on the 1939 plant layout map and the 1940 aerial photograph, a year during which much of the dye manufacturing was occurring. Figure 6-2 is a representative depiction of the general layout of the process buildings, storage building, tanks, and other surface structures during the period of active dye manufacturing.

Dyes were produced in batch runs. Therefore, an industrial process string for the production of any particular dye does not exist. Certain dyes or intermediates were primarily made within specific areas. These dyes could also easily have been manufactured in other areas as vacancies or production needs required. It is also possible that multiple dyes were produced at the same place at different times. With the exception of the Sulfuric Acid Plant and the Naphthalene Intermediate area, there is a possibility that any given dye, intermediate compound, or waste stream could have occurred within any process area of the Dyes FA.

The basic building blocks for chemicals and dyes for the Dyes FA can generally be summarized as organic compounds, commonly of benzene derivation. The base products and some of the common building-block chemicals that were used include the following:

- Base Products
  - Anthracene
  - Benzene
  - Naphthalene
  - Toluene
  - Xylenes
- Building Blocks (some common intermediates)
  - Alpha & beta-naphthylamine
  - Anthroquinone (reduced anthracene, produced at Chambers Works)
  - Benzidine
  - Chlorobenzene (chlorinated benzene, produced at Chambers Works)
  - Dinitrotoluene
  - Nitrobenzene (nitrated benzene, produced at Chambers Works)
- Catalysts/Reacting Agents
  - Nitric acid (produced at the Ordnance Works on-site)
  - Sulfuric acid (produced at the Sulfuric Acid Plant on-site)
  - Titanium chloride
- Select metals

- Antimony
- Arsenic
- Bromine
- Chromium
- Cobalt
- Copper
- Gypsum (a precipitate in some process reactions)
- Lead
- Mercury (catalyzing agent)
- Nickel (catalyst)
- Palladium
- Phosphates
- Platinum
- Sulfates

Vanadium (catalyst in sulfuric acid production)

6.2.2 Sulfuric Acid Plant

The Sulfuric Acid Plant was located within the northwestern portion of the Dyes FA (see Figure 6-2). This area included the Oil of Vitriol Plant (also known as O.V. Plant) and all production buildings, tanks, and support areas used in the production of sulfuric acid, which was widely used throughout the site. The Sulfuric Acid Plant was located south of the Carpentry and Machine Shops (Building 85), west of the Basic Colors Area, east of various storehouses of the Jackson Labs FA, and west and north of the Naphthalene Intermediate area.

Buildings in this area included the O.V. Plant, preheater and converter house, acid storage tank, and a sulfur storage area. A listing of all of the known buildings in this area is included in Appendix F.

The Sulfuric Acid Plant originally consisted of two units with two converters in series and vessels for distilling oleum using platinized asbestos as a catalyst. By 1930, this catalyst was changed to platinized magnesium sulfate. In 1945, the new Leonard Monsanto Plant began operation and used vanadium pentoxide as a catalyst. In 1946, the original units were shut down and later dismantled. The Leonard Monsanto Plant continued operation until the 1980s when it was shut down and eventually dismantled in 1998.

Sulfuric acid was an intermediate chemical supplied to various dye production areas of the site. In addition to sulfuric acid for dye operations, the Sulfuric Acid Plant also produced oleum for the DuPont Carneys Point Works to support nitrocellulose production. Based on inventory records, over 4.5 billion pounds of sulfuric acid were produced at the site from 1917 to 1958. Production is reported to have peaked at 140 million pounds per year in 1941. After 1960, the reduction in dye production at the site and decreasing nitrocellulose production at Carneys Point Works resulted in decreasing demand for sulfuric acid.

6.2.3 Naphthalene Intermediate Area

The Naphthalene Intermediate area was located south of the Sulfuric Acid Plant (see Figure 6-2). At least 27 buildings were located within this area. A listing of all of the known buildings in this area is included in Appendix F. Buildings and tanks within this area were used for the production of naphthalene and other nitrobenzene intermediate compounds that were common building blocks for dye production.

This area was primarily used to create the various intermediate compounds used throughout the site and the Dyes and White Products FAs in particular. Although complete inventory records are not available, a record search provided an indication of the diverse and complex compounds created in this area. As such, no single process history or waste stream data are available.

Because of the nature of intermediary compound batch production, record-keeping during the operational period of this area, and the large number of distinct compounds created, comprehensive production lists are not available. However, records indicate that in the years spanning the 1930s, the Naphthalene Intermediate Area produced about 6.5 million pounds of products annually. This production peaked during World War II at about 32 million pounds annually. In 1958 production was down to about 13 million pounds annually and continued to decline throughout the 1960s and 1970s until all dye-related production ended when DuPont left the dye business in 1980.

6.2.4 Basic Colors and Sulfur Colors Areas

The Basic Colors and Sulfur Colors areas were located in the northwest and south central portions of the Dyes FA (see Figure 6-2). Many building names are associated with the type of dye produced at some time, such as the "Victoria Green Building," the "Magenta Building," and the "Sulfur Blue Building." However, because some processes were relocated over time, it is likely that multiple types of dyes were produced in any given building, regardless of that building's name. Thus, the processes and chemicals used in this area are more appropriately characterized by examining the collective data, which is representative of the Basic Colors and Sulfur Colors areas as a whole.

Based on a historical records review, the amount of dyes produced per year in this area often was reported generically. However, in 1920, 16 basic colors were produced, and the recorded production was about 1 million pounds annually.

Basic dyes are typically amino derivatives (and acetic acid and softening agents) that are used mainly for application to paper. Sulfur or sulfide dyes contain sulfur or are precipitated from a sodium sulfide bath. Unlike other areas that were largely based around a particular dye process, this area was widely used to run up processes for new dyes created at Jackson Labs and other laboratories. The rate at which the Basics Color Area brought dyes to market implies that this area could have hosted many different compounds (Wingate, 1982).

According to a site retiree, dinitrophenol, a solid organic compound, was produced in the Sulfur Black Building (Building 724) located in the north-central area of the Dye FA (see Figure 6-3). As the chemical was produced, it would granulize and smaller granules would be caught in the updraft through the roof flue, from which it would settle to the

surrounding ground. The retiree had no knowledge of any activities to remove any settled material.

6.2.5 Azo Colors Area

The Azo Colors area is located in the eastern central portion of the Dyes FA (see Figure 6-2). At least ten buildings were located within this area. A listing of all of the known buildings in this area is included in Appendix F. The buildings included offices and laboratories, storage, change house, grinding and mixing, and other buildings.

Azoic dyes contain the azo (nitrogen) group and formic acid, caustic soda, metallic compounds, and sodium nitrate. These dyes were made especially for application to cotton and represent the largest quantities, in terms of pounds produced, of all dyes.

A complete discussion of the synthesis of azo dyes could fill several volumes of text. However, at its core, the creation of azo dyes involves the creation of a diazo salt and a coupling component. An example of a diazo salt is diazotized sulfanilic acid that is created through the hydrogenation and nitration of sulfanilic acid. An example of such a coupling is with diazotized sulfanilic acid and 1-naphthylamine. This reaction creates the acidic color 2-Naphthol Orange and the basic color 1-Naphthylamine Red.

Based on a records review, the amount of total dyes produced during the 1940s and 1950s was between 7 to 10 million pounds annually. These production numbers include Azo, Basic Colors, and Sulfur Black.

6.2.6 Ponsol Colors Number 1 Area

The Ponsol Colors #1 Area is located in the eastern central portion of the Dyes FA (see Figure 6-2). Ponsol #1 (Building 179) and the Ponsol Laboratory and Offices (Building 584) are located on the central-eastern portion of the Dyes FA (see Appendix F). Buildings of unknown use and designation are located immediately east of the Ponsol Building No. 1 and likely were used in the production of Ponsol dyes in some manner. At least five buildings were located within this area. A listing of all of the known buildings in this area is included in Appendix F.

In 1918, anthracene color (blue, black, yellow) production began at the site. These dyes eventually fell under the Ponsol Colors trade name. These dyes, also called vat dyes, were impregnated into fiber under reducing conditions within a vat of solutions and then reoxidized to an insoluble form. Natively, these dyes are very insoluble compounds and are some of the highest-quality (and most chemically complex) dyes ever produced.

Historically, the Ponsol # 1 building was used as a potash recovery facility. This facility became obsolete in 1925 when anthroquinone manufacturing ceased at the site. A records review indicated that the building was used for the manufacture of beta-amine intermediates and dyes as well as dye standards for the Sulfur Colors Area. In 1956, the operations were moved to Ponsol # 2 building and the next year the building was dismantled. A history of the Ponsol #2 Building is included in the White Products FA discussion (see Section 5).

6.2.7 Current Conditions

Buildings and processes within the Dyes FA have been progressively dismantled since 1980, when DuPont left the Dye manufacturing business. Figure 6-2 shows the buildings that currently occupy the Dye area. The only operating process buildings within the Dyes FA are the Ethylene Oxide and the White Products "D" building. The remaining buildings are used for storage, maintenance, change houses, or administrative offices and will not be discussed further herein.

Ethylene Oxide Center (115)

Ethylene Oxide (EtO) is purchased by DuPont from an off-site vendor and used in this area to conduct ethyloxylations. This process is used to purify chemical intermediates in support of the Performance Chemicals manufacturing. Wastewater generated during this process is pumped to the on-site WWTP.

White Products "D" Building (888)

The White Products "D" building (888) is currently part of the White Products manufacturing area and produces textile products and surfactants. Waste material from this process is sent to the wastewater treatment plant for disposal. Additional information on the White Products manufacturing process is discussed in Section 5.0.

6.3 Previous Investigations

The SWMUs identified as part of the RFI within the Dyes Focus Area include the following (see Figure 6-2). More complete descriptions of these SWMUs were submitted in January 2002, in the report titled *Chambers Works FACT Sheet* (DuPont, 2002).

6.3.1 SWMU 41-3

SWMU 41-3 was identified by the EPA during a 1987 site analysis as a drum storage area that was used to store raw materials, finished products, and waste material associated with manufacturing processes at the Chambers Works manufacturing area. This area operated prior to 1970, and it is unknown when storage ceased. SWMU 41-3 is a 0.53-acre asphalt paved area. It is currently used as a parking area and as the site of a storage building which covers the majority of this SWMU location. The location of SWMU 41-3 is shown in Figure 6-2. As part of the Phase III RFI, no further action was proposed for SWMU 41-3 because all detected soil concentrations were below NRDCSCC and IGW. This SWMU was not retained as needing further evaluation.

6.3.2 SWMU 9

SWMU 9 was an isopropyl alcohol recovery unit associated with dye manufacturing that was used from 1917 though 1948. The alcohol recovery building was demolished in 1986. The area is now a concrete pad that is used for drummed material storage. The location of SWMU 9 is shown in Figure 6-2. In 2002, a deed restriction was recorded with Salem County. An NFA and Covenant Not to Sue was issued by the NJDEP for SWMU 9; therefore, no additional work is proposed for SWMU 9. This SWMU was not retained as needing further evaluation.

6.3.3 SWMU 63

The objective of the Phase IV RFI investigation for SWMU 63 was to obtain initial characterization data for the SWMU. Results of the groundwater evaluation indicated that SWMU 63 should be considered a high priority SWMU, and removal of DNAL from G06-M03B was recommended by installation of a properly designed recovery well. A new recovery well was installed at the base of the B Aquifer (top of the B/C confining unit) in September 2005 as part of the DNAPL program (G06-M03B). Since subsequent DNAPL surveys in the new recovery well did not detect the presence of DNAPL. DuPont recommended to continue the delineation efforts in the area.

The extent of DNAPL in SWMU 63 has been delineated to the north and south as part of the Salem Canal seep delineation work. However, further delineation in the vicinity of well G06-M03B, and the eastern and western portions of SWMU 63 were deemed necessary.

The work plan (December 21, 2005) was developed using the results and recommendations from the Phase IV RFI report (April 2005). The SWMU 63 investigation is currently ongoing as part of the Phase IV RFI Supplemental Investigation Work Plan. The work plan includes further soil and groundwater investigation in order to better characterize the area for prioritization purposes.

SWMU 63 was retained during the evaluation.

6.3.4 Salem Canal Seep Investigation

In August 2002, during drought conditions, a purple colored seep was discovered entering the Salem Canal from the site. The NJDEP hotline was notified as was the NJDEP case manager. DuPont installed an emergency boom/silt curtain around the area of observed surface water discoloration, approximately 100 feet in length to contain the seep.

In 2002, investigative activities were initiated, including sampling and analysis of surface water and groundwater in the area of the seep to chemically characterize the seep and to evaluate groundwater containment. Because the canal is used for the plant's fire, process, and potable water supply, the potable water intake was sampled to confirm that contamination was not present. Sampling of Munson Dam potable water intake occurs on a regular basis and current results continue to be below method detection limits. Constituents detected in the seep were primarily organic compounds.

A more extensive surface-water and sediment sampling event was conducted in 2004 to delineate the extent of contamination in sediment. Constituents detected in the sediment exceed screening criteria, but there were no constituents in surface water above ecological criteria inside or outside the silt curtain/boom in November 2004.

In order to determine the source of the contamination, DuPont developed a conceptual model for the seep area. Potential seep source areas were evaluated by reviewing historical aerial photographs, and conducting interviews with former employees. Groundwater sampling conducted in 2003 and 2004 also helped confirm the area of impacted groundwater. The likely source of the contamination was determined to be

related to the former Azo dye manufacturing area (now SWMU 63). Azo dye manufacturing occurred in the area from approximately 1918 until 1980. A report summarizing the investigation of the Salem Canal seep area through 2005 was completed and submitted to the NJDEP in June 2005 (Salem Canal Interim Remedial Measure Selection Report).

Based on recommendations in the ISM report, a Pre-Design Investigation work plan was developed in November 2005. Fieldwork for the hydrogeologic and geologic portions of the investigation were completed from December 2005. Currently, groundwater modeling for the area is being completed to better evaluate potential remedial design options. Sediment sampling for delineation purposes is currently ongoing.

The Salem Canal seep area was retained during the pathway evaluation.

6.3.5 SWMU 17 and SWMU 56A

Sections of SWMU 17 and SWMU 56A are located within the Dyes FA. Details about these SWMUs are presented in Section 4.3.1.

6.4 Pathway Analysis

The following pathway analysis was performed in accordance with the methodology described in Section 3.7.1. For the Dyes FA, some areas were identified for further evaluation. This conclusion was based on the historical area review, aerial photograph evaluation, review of existing data from various media, review of historical investigations, and review of existing remedial documentation. This section provides the information that was collected and discusses the evaluation that was conducted.

This pathway analysis used, to the extent possible, the existing environmental data in accordance with the NJDEP Technical Requirements. Relevant tables are provided in the CD in Appendix D.

- Chemical Process Database: The chemical database does not contain any relevant data for the Dyes FA. Since no chemical processes have ever been done in the Administration Building, this building was not retained for evaluation.
- Buildings, Trenches, and Utilities Review: The GIS Building layer, Ditches/Trenches/Outfalls layer, and the Utilities layer were reviewed for this focus area.
- Soil Data: Soil analytical data for this focus area is provided in Appendix D. Boring locations and chlorobenzene concentrations are shown in Figures 6-4 and 6-5.
- Sediment Data: Sediment analytical data for this focus area are provided in Appendix D. Sediment sample locations and chlorobenzene concentrations are shown in Figure 6-6. Sediment data for this focus area are related to SWMU 41-3 as well as the Salem Canal Study area.
- Surface-Water Data: Surface-water analytical data for this focus area are provided in Appendix D. Sample locations and chlorobenzene concentrations are shown in

Figure 6-7. Surface-water data for this focus area are related to the Salem Canal Study area. These samples are discussed in more detail below.

- Groundwater Data: Groundwater analytical data for this focus area are provided in Appendix D. Chlorobenzene concentrations in B Aquifer wells are shown in Figure 6-8. In general, groundwater flows towards the east-northeast towards IWS pumping well. In the vicinity of the canal, groundwater flow direction is either towards or away from the canal depending on seasonal conditions.

This pathway analysis used, to the extent possible, the existing environmental data in accordance with the NJDEP Technical Requirements as noted above. A primary manufacturing component in the Dyes FA was chlorobenzene, and this compound was most commonly detected in the soil, sediment, and groundwater samples. Therefore, chlorobenzene is used to illustrate the contaminant distribution.

In addition, the Administration area and Carpentry area are not considered for further evaluation in the pathway analysis because these areas have served as non-production areas since dye production began in 1917. For evaluation of the Dyes FA, all process areas were combined as an area of interest due to limited available analytical and historic process data.

6.4.1 All Process Areas

As discussed throughout the pathway analysis evaluation, the following process areas within the Dyes FA warrant a pathway analysis:

- Sulfuric Acid Plant Area
- Naphthalene Intermediate Area (including SWMU 63)
- Basic Colors and Sulfur Colors Areas (two areas)
- Azo Colors Area
- Ponsol Colors Area

These areas have been combined into one unit for the pathway evaluation because they share a common production history using similar compounds, production methods, and disposal practices.

In general, review of the compounds detected in soil, sediment, and groundwater are consistent with the chemicals used with the Dyes Area and within the site in general. In the area of SWMU 63 and the Salem Canal seep investigation area, constituent concentrations in soil and groundwater are above applicable criteria, and DNAPL is present in three wells.

As shown in the figures, there are few soil and groundwater sample locations throughout the Dyes FA. Given the high constituent concentrations and presence of DNAPL and the network of former process wastewater ditches, other source areas may be present in this focus area. Therefore, additional sampling is recommended.

6.5 Summary of Recommendations

Based on the pathway analysis, the following is recommended for the Dyes FA:

- Collect groundwater samples in the Basic Colors area because there are currently insufficient analytical data to characterize groundwater quality in this area.
- Collect groundwater samples in the vicinity of the process wastewater ditches and process building trenches in the Sulfuric Acid Plant area, Basic Colors-Sulphur Colors area, Naphthalene Intermediate area, and Azo Colors area to assess groundwater quality and potential presence of DNAPL.
- Evaluate sediment quality in the vicinity of the historical process wastewater outfalls along the Salem Canal. The sampling will be performed as part of the perimeter investigation.

Groundwater samples may be collected from wells that are currently not used for sampling purposes, where present, or by installing additional monitoring wells, for example. Details about the recommended investigations, such as the number and location of monitoring wells, sampling locations, and sampling methodologies, will be presented in subsequent work plans.

Areas recommended for investigation are shown in Figure 6-9.

7.0 FOCUS AREA – JACKSON LABS

Assessment of the Jackson Labs FA indicates that further investigation is warranted throughout the FA except in the Power and Utilities (P&U) area. The recommended investigations are based on the evaluation of historical process data, aerial photographs, site maps, analytical results of soil, sediment, and groundwater sampling, and on a pathway analysis. The review and analyses were conducted consistent with applicable regulations and guidelines.

Monitoring wells along the perimeter of the FA along the Delaware River indicate elevated levels of site-related constituents. These detections may be the result of historical discharges in the vicinity of Buildings 1205, J-26, Former Building 36 (Indigo Factory), and Building J-24, where most of the process wastewater ditches were present. Therefore, collection of groundwater samples is recommended to evaluate groundwater quality and the presence of NAPL and DNAPL in order to assess these features as potential sources of groundwater contamination. Similar sampling is recommended in the vicinity of an outfall sump.

DuPont recommends additional groundwater sampling along the site perimeter in the southwest portion of the FA where there are limited analytical data to evaluate groundwater quality and the potential for groundwater to surface-water pathways. In addition, installation of additional wells may be needed in order to enable calculation of horizontal hydraulic gradient and therefore assess hydraulic containment by the IWS.

The Jackson Labs FA borders the Delaware River and Salem Canal. Therefore, sediment sampling in the vicinity of former process wastewater outfalls is recommended in order to evaluate the potential impact of legacy discharges.

The rail unloading area adjacent to process buildings in the Indigo area may have had historical releases. Therefore, DuPont recommends additional groundwater sampling downgradient of the primary Indigo unloading areas to enhance spatial coverage and to evaluate groundwater quality for the presence of site-related constituents.

The full evaluation is presented in the rest of this section. Details about the recommended investigations, such as the number and location of monitoring wells, sampling points, and sampling methodology, will be presented in subsequent work plans.

7.1 Areas of Interest

The Jackson Labs FA is approximately 32 acres in the southwest corner of the site (see Figure 7-1). It is bounded by the Salem Canal to the south, the Delaware River to the west, Fire Road to the north, and Main Street to the east.

Based on common processes, history, chemical use, and disposal practices, the Jackson Labs FA has been divided into four sub areas (see Figure 7-1):

- The Laboratories area is in the southwestern portion of the focus area where laboratories and support buildings were located for chemical process research and development.

- The Semi-Works area is in the northwestern portion of the focus area where pilot-scale chemical production occurred. This area currently produces chemical intermediates for the elastomers business at the site.
- The Power and Utilities area is in the southeastern portion of the focus area where the powerhouse and water treatment plant are located.
- The Former Indigo Heavy Chemicals area is in the northwestern portion of the focus area where the Indigo Dye manufacturing operation was located.

As shown in Figure 7-2, several SWMUs are located within the Jackson Labs FA and have been investigated and/or remediated as part of the Chambers Works RFI program. These SWMUs are covered in Section 7.2 but do not require additional evaluation as part of the pathway analysis since no new information was identified that requires additional investigation:

- SWMU 28: Telomer "A" Waste Container Storage
- SWMU 29: Telomer "A" Waste Treatment Tank
- SWMU 33: Manhattan Project-Related Area
- SWMU 31: Fly Ash Disposal Area
- SWMU 51: Well DW-8
- SWMUs 41-6 and 41-7: Drum Storage Areas 6 and 7

More complete descriptions of these SWMUs were submitted in January 2002, in the report titled *Chambers Works FACT Sheets* (DuPont, 2002).

Based on the aerial photograph review and process knowledge, several areas of interest were selected for further evaluation:

- Former Outfalls Associated with SWMU 17
- SWMU 39-5 [Former Underground Storage Tank (UST) and Aboveground Storage Tank (AST) location]
- Main Switching Station and Transformer Pad area
- Rail Unloading Spots in Former Indigo Heavy Chemicals and Naphthalene areas

The areas of interest are shown on Figure 7-3.

7.2 History

Before 1917, the location of the Jackson Labs FA was a residential community known as Fenton's Beach, consisting of 62 individual lots and associated streets. In 1917, DuPont began to purchase the individual lots and consolidate them into a single property for the Deepwater Dye Works. The property acquisition continued until the final lot was purchased in 1927.

Initial construction of the Deepwater Dye Works began in 1917 with the construction of the Jackson Laboratory and the Technical Laboratory for research and development activities. The Power and Utilities buildings (powerhouse, boiler house, substation,

icehouse, and filter plant) were constructed to supply electricity, steam, potable water, ice, and compressed air to the Dye Works. DuPont also constructed the Indigo Heavy Chemicals buildings and associated railroad spurs directly north of the Power and Utilities area to manufacture synthetic indigo dyes. In 1918, DuPont began the Semi-Works operation by installing equipment in the former Fenton's Beach schoolhouse. Initially, Semi-Works activities included process development and pilot-scale production of dye formulations developed by the Jackson Labs research and development (R&D) department. Additional construction continued from 1918 to 1927 as the remaining residential properties were acquired and replaced with buildings associated with the Deepwater Dye Works.

Current operations in this FA are discussed below by areas within the FA.

7.2.1 Laboratories Area

The Laboratories area includes 12 primary buildings used for laboratory research and development and office space, and approximately 30 support buildings used for storage shops (carpenter, machine, glassware, etc), and the Chambers Works plant fire house. Research and development activities in the Jackson Labs FA have continued without interruption from 1917 to the present. Initially, R&D activities were focused on the dye business but grew rapidly to support other products, including petroleum additives, synthetic rubber (Neoprene), Freon, plasticizers, Teflon®, Nomex, and Kevlar. Product formulations and manufacturing processes were developed in the laboratories and later pilot-tested in the Semi-Works area if the development showed promise. Many product formulations and processes evaluated in the laboratories did not progress to the pilot test stage. Historical records indicate that nearly every chemical that was ever used or produced in any operating area of the Chambers Works was tested in the laboratories at some point (DuPont, 1978). Process waste from the buildings in the laboratory area was historically conveyed to the adjacent process waste ditch and is currently collected in waste sumps and pumped via overhead pipeline to the on-site WWTP.

There are no SWMUs located within the Laboratories Area other than sections of SWMU 17 (see Section 4.3.1).

7.2.2 Semi-Works Area

The Semi-Works area currently contains three process buildings (J-26, 1205, and 207), an office building, and several storage buildings/sheds currently associated with the DuPont Performance Products division (see Figure 7-2). Pilot testing has been conducted in these buildings, and several previously demolished buildings, to troubleshoot the manufacturing process prior to large-scale production in other areas of the site. The pilot-scale test runs required several months to several years depending on the product line. At the conclusion of pilot-scale testing, the process building was retrofitted with the equipment needed for the next set of tests. Product formulations and processes yielding successful test runs were relocated to other operating areas of the Chambers Works for large-scale production if there was a market for large quantities of the product. In many cases, the Semi-Works operations generated quantities sufficient to meet market demand and, for that reason, continued producing products for an extended period of time. Over

time, significant quantities were manufactured in the Semi-Works area. For example, in the 18-year period between 1940 and 1958, over 3,000 pilot-scale test runs were conducted and over 85 million pounds of products were produced (DuPont, 1978). These products included finished products that were shipped to off-site customers, or intermediate products that were supplied to other operating areas of the Chambers Works.

Current operations in the Semi-Works area include specialty monomer production in support of the elastomers product line. These operations are part of the Performance Chemicals West (PC West) area and include Buildings 1205, 1207, J-25, and J-26. The three specialty monomers are C_4/C_6 mixed perfluoro-dido alkanes (PDA-4,6), idodetrafluoro-1butene (ITFB or Monomer 4431), and bromotetrafluoro-1-butene (BTFB). These monomers are used by the DuPont Performance Elastomers operation to make Viton synthetic rubber.

SWMU 28 (Telomer "A" Waste Container Storage Area)

SWMU 28 is a concrete loading bay attached to Building 1050 that is completely enclosed and elevated approximately 3 feet above grade. The storage area floor consists of concrete that is sloped to a drain that leads to the WWTP. Concrete or asphalt covers the area outside of the porch for 50 feet in all directions. The waste that was stored at SWMU 28 was a highly corrosive sludge that generated hydrofluoric acid upon exposure to water or moist air. Wipe sampling conducted during closure of the storage area did not detect Telomer A waste residue (iodide and fluoride). The RCRA-regulated unit was certified as partially closed by NJDEP in a letter dated November 18, 1986. As part of the Phase III RFI, a soil and groundwater sample were collected and analyzed for SWMU related constituents (iodide and fluoride). Groundwater sampling results indicated the presence of fluoride and iodide in groundwater, but no regulatory criteria were available for comparison. The RCRA Unit Post Closure Monitoring Program began for this SWMU in July 2003 in accordance with the NJPDES-DGW permit No. NJ0083429. A downgradient well (C08-M01B) is monitored annually for SWMU-related constituents (iodide, fluoride, and antimony) and reported in the NJPDES-DGW Semiannual Status Report.

SWMU 29 (Telomer "A" Waste Treatment Tank T-130)

SWMU 29 is the Telomer "A" catalyst residue and filter bag treatment facility waste treatment tank T-130. This unit was closed in accordance with the DuPont closure plan dated July 26, 1990 and the NJDEP Hazardous Waste Facility Permit dated June 17, 1998. Closure of this unit was documented in the *NJ Licensed Professional Engineers Certification of Closure Report Telomer "A" Catalyst Residue and Filter Bag Treatment Facility, DuPont Chambers Works, Deepwater NJ* dated April 30, 2001.

SWMU 33 (Manhattan Project-Related Area)

Six areas are identified as SWMU 33 at the site. These areas are currently being investigated by the USCOE as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP) project. A portion of SWMU 33 (see Figure 7-2) is located in the Jackson Labs FA within the footprint of Building J-26. In 2006, the USCOE conducted groundwater and soil sampling around Building J-26 to screen for the presence of uranium related to former Manhattan Project activities. The final investigation report is

expected to be available in early 2007. During the FUSRAP investigation, the presence of NAPL was reported in the A fill zone to the northeast of Building J-26. DuPont installed an A zone well (D08-M01A) in late 2005 to screen for the presence of the observed NAPL. Monthly NAPL screening has been conducted during 2006 and NAPL has not been detected. Results of the NAPL screening program are reported in the NJPDES-DGW Semi-Annual Status Reports.

7.2.3 Power and Utilities Area

The Power and Utilities area contains two primary operating buildings and several supporting structures. These buildings (powerhouse, boiler house, substation, icehouse, and filter plant) were constructed to supply electricity, steam, potable water, ice, and compressed air to the Dye Works in 1917. Water was initially obtained from supply wells located on-site, but the amount of water wasn't sufficient to meet plant needs. In 1933, DuPont constructed Munson Dam across the Salem Canal at the site (and Brown's Dam several miles upstream) to isolate the freshwater Salem Creek from the brackish water in the Delaware River, creating a freshwater reservoir. A freshwater intake was constructed at Munson Dam, and a water filtration system was constructed south of the Boiler House. The boilers were initially designed to burn coal, but later were converted to use oil prior to 1939. By 1957, the energy needs of Chambers Works exceeded the existing capacity, and DuPont began to obtain steam and electricity from the Atlantic Electric Deepwater generating station located south of the Salem Canal. Between 1959 and 1962, the fuel oil storage tanks were removed and replaced with a new water treatment plant. DuPont has been supplied with steam and electricity from the Carneys Point Cogeneration Facility since the early 1990s. Current operations in the Power and Utilities area include distribution of steam and potable water to the site in addition to producing and distributing compressed air. The water treatment plant operates in compliance with both federal and state Safe Drinking Water Act requirements. Monitoring results are reported to the NJDEP Bureau of Safe Drinking Water under program ID PWSID No. NJ1708300.

SWMU 31 (Power Plant Coal Pile and Fly Ash Disposal Area)

SWMU 31 consisted of the former coal pile for the Chambers Works powerhouse and fly ash resulting from the powerhouse operation. Coal was fed to the powerhouse boilers to produce steam for the plant. This practice ended in the 1950s when electric generation ceased and the powerhouse was used to provide compressed air for the plant. The area is now paved with asphalt.

As part of the Phase III RFI, a soil and groundwater sample were collected and analyzed for TCL organics plus 10 and TAL metals. Soil results did not indicate SWMU-related constituents above NRDCSCC. Groundwater results indicated concentrations of some metals and polynuclear aromatic hydrocarbons (PAHs) above criteria. The elevated metals results were thought to be elevated due to the turbidity of the sample resulting from the sampling method (DuPont, 2002). Groundwater in the area is captured by the IWS and no additional investigation was proposed for SWMU 31.

SWMU 51 (Well DW-8)

Production well DW-8 (E07-W01F) was equipped with an oil-lubricated pump from approximately 1943 to 1962. The pump was replaced with a water-lubricated pump in

1962. The water-lubricated pump was removed in April 1989 due to the presence of oil in the well. The source of the oil was determined to be the lubricating oil from the pump. In a letter dated July 25, 1995, the EPA and NJDEP agreed that DW-8 was thoroughly investigated and required no further action.

7.2.4 Former Indigo Heavy Chemicals Area

The Indigo Heavy Chemicals area was constructed in 1917 and operated continually until DuPont ceased production in the early 1970s. Primary buildings in the area included the Indigo Factory (Building 36), Indigo Storage & Shipping (Building 603), Indigo Melt (Building 33), Caustic Melt (Building 43), as well as shops, storage sheds, and an office. The primary product in this area was a synthetic indigo dye. This dye was first produced by reacting chloroacetic acid, aniline, ferrous sulfate, and caustic soda to form iron glycine. Iron glycine was treated with caustic soda and caustic potash to form phenylglycine, the primary intermediate for indigo dye. The initial process included several washing and filtration steps that reduced efficiency. In 1920, an improved glycine process based on formaldehyde and sodium cyanide was adopted, improving efficiency. In the 40-year period from 1919 to 1959, approximately 260 million pounds of indigo paste and powder were produced. Process wastewater from the manufacturing process was conveyed into the PWDS (SWMU 17; see Section 4.3.1) located along the western edge of the operating area. A rail yard located to the east of the operating area was used for loading/unloading of raw materials and finished product. This rail yard was shared by both the Indigo Heavy Chemicals area and the Naphthalene Intermediates area to the east. The operating buildings associated with the indigo dye production were removed prior to 1974 with the exception of Building 603, which is currently used as office space.

SWMUs 41-6 and 41-7 (Drum Storage Areas)

SWMUs 41-6 and 41-7 are drum storage areas within the Former Indigo Heavy Chemicals Area (0.47 acres and 0.64 acres, respectively) that were used to store raw materials, finished products, and waste material associated with manufacturing processes at the site. Currently, both SWMUs are covered with gravel. These SWMUs were investigated as part of the Phase I RFI. Results indicated that all VOCs, SVOCs, and metals concentrations were below NRDCSCC. An NFA and Covenant Not to Sue were issued by the NJDEP for SWMUs 41-6 and 41-7 on October 24, 2002.

7.2.5 SWMU 17

Sections of SWMU 17 ditches are located within the Jackson Labs FA. Details about SWMU 17 are presented in Section 4.3.1.

7.3 Pathway Analysis

The following pathway analysis was performed in accordance with the methodology described in Section 3.7.1. For the Jackson Labs FA, areas were identified for further evaluation. This conclusion is based on review of historical area information, aerial photographs, existing data from various media, previous investigations, and existing

remedial documentation. This section provides the information that was collected and discusses the evaluation.

This pathway analysis used, to the extent possible, the existing environmental data in accordance with the NJDEP Technical Requirements. Relevant tables are provided in the CD in Appendix D.

- Chemical Process Database: The chemical process database was queried for the buildings that exist or existed in this focus area. Historical process research indicates that solid waste material was usually removed from the area and transported to other areas of the site for incineration or landfill disposal. Liquid waste was drummed for incineration and or landfill disposal, or discharged to the PWDS.
- Buildings, Trenches, and Utilities Review: The GIS Building layer, Ditches/Trenches/Outfalls layer, and the Utilities layer were reviewed for this focus area.
- Soil Data: Soil analytical data for this focus area are provided in Appendix D. Sampling locations are shown in Figures 7-4 and 7-5, with soil results posted for chlorobenzene compared to NRDCSCC and IGW, respectively.
- Sediment Data: No sediment analytical data for this focus area were available.
- Surface Water Data: No surface water analytical data for this focus area were available.
- Groundwater Data: Groundwater analytical data for this focus area are provided in Appendix D for VOCs, SVOCs, pesticides, herbicides, metals, and TICs for the active and abandoned B Aquifer wells.

  Grab groundwater data collected from temporary well-points for this focus area are provided in Appendix D.

  In compliance with the NJPDES-DGW Permit No. NJ0083429, groundwater quality in site perimeter wells is monitored. The wells in proximity to this focus area that are monitored as part of the DGW program (F06-M02B, D06-M01B, C07-M01B, and C08-M01B) are shown in Figure 7-6.

  The shallow groundwater flow (see Figure 7-6) in the Jackson Labs FA is tidally influenced by the Delaware River to the west. Groundwater in the B Aquifer in the western portion of this FA flows toward the river while the eastern portion flows to the east toward the IWS pumping wells.

The general suite of SVOCs present at many areas at the site has also been detected in soil and groundwater in the Jackson Labs FA. PCE was present at elevated concentrations at most locations and therefore is used to illustrate the contaminant distribution. Analytical data for all constituents in soil and groundwater were reviewed in addition to PCE.

7.3.1 Former Outfalls Associated with SWMU 17

Several historical outfalls were located in the Jackson Labs FA that may have discharged process wastewater to the Delaware River.

Sediment samples will be proposed in the perimeter investigation work plan to characterize the sediment in the river for site-specific constituents. This work plan will be submitted after agency review and approval of the PAR.

The process waste sump associated with former permitted outfall 010 has been historically used as a collection point for process wastewater in the area. It is located at the site boundary in and area where B aquifer discharges to the Delaware River and may have historically released site constituents to the B Aquifer. Therefore, groundwater sampling at this location is recommended to evaluate groundwater quality and potential groundwater to surface-water pathways.

7.3.2 SWMU 39-5 (Former UST and AST location)

SWMU 39-5 was the location of a former UST adjacent to Building 1128 (Water Treatment Plant) and two aboveground oil storage tanks from 1917 to 1960. For the aboveground tanks, secondary containment berms were present. The UST was removed, and soil was checked for visual evidence of contamination and odor after UST removal; no evidence of leakage was observed. In a letter dated December 6, 1993, the EPA agreed that SWMU 39-5 required no further action.

SWMU 39-5 is near the southern perimeter of the Power and Utilities Area where groundwater containment in the B Aquifer is uncertain. In addition, groundwater data in the area are limited. Transformers and switching stations are also present in this area. Therefore, DuPont recommends additional investigation in this area to evaluate groundwater quality and potential groundwater to surface-water pathways.

7.3.3 Rail Unloading Spots in Former Indigo and Naphthalene Areas

Rail unloading spots adjacent to process buildings that have been in continual operation have the potential for historical releases to soil and groundwater. Groundwater data and soil data in the area are limited; therefore, the potential for historical releases to the environment is unknown.

DuPont proposes investigation of groundwater adjacent to the primary Indigo and Naphthalene unloading spots to enhance spatial coverage in the area and to evaluate groundwater quality for the presence of site-related constituents.

7.3.4 Groundwater Evaluation

Evaluation of PCE in soil and shallow groundwater was chosen for evaluation for the Jackson Labs FA because it was commonly used material in the area and was also detected in soil and groundwater in this area. Soil concentrations of PCE are posted in Figure 7-4 and 7-5, and groundwater concentrations are shown in Figure 7-6. An evaluation of available groundwater quality data indicates detections of site constituents

above criteria. A lack of spatial coverage for groundwater prevents adequate delineation of the extent of the current groundwater impact in this FA.

Process sumps and ditches associated with operating Buildings have the potential for historical releases to the environment. Several buildings were identified in consideration of the operational history, waste disposal practices, and review of available groundwater quality data as having an increased potential for historical releases for additional evaluation. These buildings include the following:

- J-26 (Jackson Labs Product Development Laboratory)
- 1205 (Performance Products West Miscellaneous Products)
- Former Building 36 (Indigo Factory)
- J-24 (Pharmaceutical Chemicals R&D)

DuPont proposes additional investigation to access the potential releases from process sumps and ditches adjacent to these buildings to evaluate groundwater quality for the presence of site-related constituents.

7.4 Summary of Recommendations

Based on the pathway analysis, the following is recommended for the Jackson Labs FA:

- Collect groundwater samples along the site perimeter in the southwestern portion of the Labs area, including the sump location of the former outfall, to evaluate groundwater quality and potential groundwater to surface-water pathways.
- Collect groundwater samples in the vicinity of the process wastewater ditches and process building trenches in the area of buildings J-24, J-26, 36, and 1205 to assess groundwater quality and potential presence of DNAPL.
- Collect groundwater samples downgradient of the former Indigo and Naphthalene loading/unloading area to evaluate the potential effects on groundwater quality.
- Measure hydraulic head in aquifer at multiple locations near the FA perimeter to calculate horizontal hydraulic gradient and therefore assess hydraulic containment by the IWS.
- Evaluate sediment quality in the vicinity of the historical process wastewater outfalls along the Delaware River. The sampling will be performed as part of the perimeter investigation.

Groundwater samples may be collected from wells that are currently not used for sampling purposes, where present, or by installing additional monitoring wells, for example. Details about the recommended investigations, such as the number and location of monitoring wells, sampling locations, and sampling methodologies, will be presented in subsequent work plans.

Areas recommended for investigation are shown in Figure 7-7.

8.0 FOCUS AREA – TEL

Assessment of the TEL FA indicates that further investigation is warranted throughout the FA. The recommended investigations are based on the evaluation of historical process data, aerial photographs, site maps, analytical results of soil, sediment, and groundwater sampling, and on a pathway analysis. The review and analyses were conducted consistent with applicable regulations and guidelines.

The TEL area was used to produce anti-knock fuel additives, mainly tetraethyl lead (TEL). Tetramethyl lead (TML), trimethylethyl lead (TMEL), and sodium-lead alloy were also produced, so the primary manufacturing component in the TEL FA was lead. Accordingly, lead has been detected at elevated levels in soil throughout much of this FA. Concentrations of total lead in groundwater in the western portion of the FA exceed applicable criteria. Insufficient groundwater analytical data exist to define the groundwater concentration throughout the FA. Therefore, additional groundwater sampling is recommended to characterize groundwater quality downgradient of and in the former manufacturing area.

Groundwater flow is predominantly toward the east as a result of the IWS. However, based on the water levels in the current monitoring wells, which are mostly along the site perimeter, there appears to be a groundwater divide such that shallow groundwater may be flowing towards the Delaware River. Measurement of hydraulic head at additional locations is therefore recommended to enable calculation of the horizontal hydraulic gradient and therefore confirm hydraulic containment by the IWS.

Currently, there are no monitoring wells on the eastern portion of the FA. Collection of groundwater samples downgradient of the former TEL area, associated ditch system, and ethyl chloride AST farm and railroad loading/unloading area is recommended in order define the spatial distribution of site-related constituents in groundwater and to evaluate whether these areas are sources of groundwater contamination.

The TEL FA is bordered by the Delaware River. Therefore, sediment sampling in the vicinity of former process wastewater outfalls is recommended in order to evaluate the potential impact of legacy discharges.

The full evaluation is presented in the rest of this section. Details regarding the recommended investigations, such as number and location of monitoring wells, sampling points, and sampling methodology, will be presented in subsequent work plans.

8.1 Areas of Interest

The TEL FA encompasses approximately 38.5 acres along the eastern bank of the Delaware River. The TEL FA is bounded by the Delaware River to the west; the Fluoroproducts FA to the north; Jackson Labs FA to the south; and the Aramids, Triangle, and Dyes FAs to the east (see Figure 8-1).

A number of areas are pertinent to the TEL FA history, as shown in Figure 8-2. These include the following four SWMUs where investigations/remedial measures have been completed and do not warrant any further discussion in the pathway analysis section:

- SWMU 25: Lead Flue Dust and Lead Furnace Slag Storage Area
- SWMU 39-2: Underground Storage Tank
- SWMU 40: Fuel Oil Storage Tanks
- SWMU 41-8: Drum Storage Area

A pathway analysis of the Antiknocks area (SWMU 57) was conducted to determine if additional investigation is necessary. This area includes SWMU 6 (Landfill II), C Ditch Process Water Ditch System, TEL process and storage buildings, ethyl chloride AST farm, and railroad loading/unloading areas.

In Figure 8-3, the areas of interest are labeled. More complete descriptions of SWMUs were submitted in January 2002, in the report titled *Chambers Works FACT Sheets* (DuPont, 2002).

8.2 History

Tetraalkyllead compounds (including TEL) were marketed for use as gasoline motor fuel additives (leaded gasoline), which suppress engine "knock" and hence were called "anti-knocking" agents.

The original process involved lead sodium alloy containing 17.2% sodium, which was made in 2,900 pound lots by melting lead and sodium in a steel kettle and casting into large pans with loose covers. The alloy was then allowed to cool and solidify and was ground under a blanket of CO_2 and discharged into milk cans. Sodium bromide was then reacted with ethyl chloride in a medium of sulfuric acid and distillation of the reaction mass.

The first location of TEL production was in the idle Saltpeter Refinery Building (left over from Carneys Point and WWI), which was remodeled, and equipment was installed for producing ethyl bromide, lead disodium, and TEL. Plant production of TEL started in August 1923. In August 1924, TEL production reached a rate of 1.2 million pounds per year. In 1924, a new plant (called "A") was being built for ethyl chloride process of TEL, which did not require the use of bromine. Ethyl chloride was not manufactured in the TEL area. However, it was used in the process of TEL production and was stored in several storage tanks in the focus area as shown in Figure 8-2.

In 1925, DuPont separated the TEL area into its own distinct operation area. Ethyl chloride was purchased from other firms from 1924 until 1927, when the Basic Color area was assigned to manufacture ethyl chloride for TEL. Additional ethyl chloride facilities were installed at the site in 1937 and 1943; however, DuPont still purchased it from other firms (Dow, Shell, and National Distillers).

In 1929, the second TEL building plant "B" started production. In 1930, the third plant "C" started production. A fourth building "D" was built in 1930 and by 1935 a fifth building, plant "E", was in operation. Additionally in 1935, ethyl chloride bulk storage

and recalcification equipment was moved to a remote location. Production increased during WWII to meet demand for use in both auto and plane fuel. Due to increases in demand, DuPont worked on accelerating the reaction rates and developed a process that used acetone as a catalyst. By 1957, the production for the Antiknocks area was 194 million pounds per year.

The EPA began to regulate the lead content of domestic gasoline starting in approximately 1973. This resulted in a gradual decline in the production of TEL at the site, which ultimately led to the business shutdown in 1991 and decontamination and demolition of the site structures between 1991 and 2001. Approximately 300,000 pounds per day of TEL was produced in the last few production years.

Aqueous streams from the TEL area were combined with water run-off from the production area and pumped to an accelerator clarifier for lead recovery. The clarifier required pH adjustment with hydrochloric acid (HCl) due to the high pH of the wastewater. The adjustment facilities precipitated inorganic lead salts, which were dewatered with a centrifuge. Solids recovered in the centrifuge were directed to a spray furnace for lead recovery.

The clarifier overflow was discharged into the "C" Settling Basin (SWMU 16; see Section 12) to which sodium borohydride was added. The overflow from the basin was directed to the plant wastewater treatment facility while the dredged solids were centrifuged.

Additional process information is provided in Appendix H. Groundwater and soil data associated with the TEL area are further discussed in the pathway analysis section.

8.2.1 SWMU 25: Lead Flue Dust and Lead Furnace Slag Storage Area

SWMU 25 was an asphalt storage area used exclusively for the storage of lead wastes produced at the Thermal Decontamination Furnace (SWMU 21) and lead treatment areas (see Figure 8-2). Waste were stored here and later shipped off-site for disposal. Because lead flue dust was designated as a hazardous waste under RCRA, SWMU 25 is regulated under RCRA.

During a site inspection conducted by representatives of the NJDEP Bureau of Planning and Assessment, cracks in the asphalt pavement were observed. A sampling program was developed to analyze for total lead to determine the extent of contamination. Asphalt sample results were elevated for lead, so the asphalt surface was washed and resampled. Lead concentrations in the asphalt samples remained elevated. Lead concentrations in groundwater samples were also elevated. In 1991, remedial actions conducted by DuPont included the excavation of the asphalt pad, placing a layer of geotextile over the area exposed by the removal of asphalt and placing crushed stone over the area. The underlying soil was to be addressed as part of SWMU 57. SWMU 25 has been certified closed by the NJDEP. The RCRA Unit Post Closure Monitoring Program began for this SWMU in July 2003 in accordance with the NJPDES-DGW permit No. NJ0083429. A downgradient well is monitored annually for SWMU-related constituents and reported in the NJPDES-DGW Semiannual Status Report. The groundwater in this SWMU is monitored as part of the perimeter monitoring plan. No further work is being proposed in this area.

8.2.2 SWMU 39-2: Underground Storage Tank

SWMU 39-2 is part of a network of 19 former USTs that were located at the site (see Figure 8-2). These tanks contained gasoline, diesel, or waste by-products. The tanks have been removed; no visual evidence of leakage was observed during removal. Based on these results, the EPA agreed to no further action for SWMU 39 and no further work is proposed as a result of this evaluation.

8.2.3 SWMU 40: Fuel Oil Storage Tanks

SWMU 40 comprises three fuel oil storage tanks (TS-1, TS-2, and TS-3) as shown in Figure 8-2. TS-1 and TS-2 were constructed in the 1930s, and TS-3 was constructed in the 1970s. The tanks were once used to store No. 6 fuel oil, but have been emptied and are currently not in use. SWMU 40 is surrounded by an asphalt and gravel covered berm, and each tank is spill controlled by an asphalt-covered dike containment structure. Soil samples collected from within and around SWMU 40 did not indicate the presence of fuel oil. Piezometers in the area have not indicated the presence of free product. DuPont recommended no further action in the Phase II RFI for SWMU 40; and, based on this review, no further work is proposed.

8.2.4 SWMU 41-8: Drum Storage Area

SWMU 41-8 is a former drum storage area, which had been used to store raw material, finished products, and waste material associated with manufacturing operation at the site (see Figure 8-2). SWMU 41-8 was sampled as part of the Phase II RFI and data indicate benzo(a)pyrene concentrations slightly exceeded NRDCSCC. Additional sampling indicated benzo(a)pyrene concentrations were below the NRDCSCC and that the area has been delineated. Currently, the SWMU is covered with concrete and is no longer active. DuPont recommended no further action in the Phase II RFI for SWMU 41-8; and, based on this review, no further work is proposed.

8.2.5 Antiknocks Area

The Antiknocks area (SWMU 57) is a 25-acre section of the TEL FA located along the eastern bank of the Delaware River (see Figure 8-1). This area was used in the production of MFAC using tetraethyl lead and related compounds from 1923 until 1991. In addition to TEL, the Antiknocks area was used to produce tetramethyllead (TML), tetramethyl-ethyl lead (TMEL), and sodium-lead alloy.

Seventeen buildings (648, 648A, 1249, 647, 1121, 1258, 1170, 765, 856, 1032, 618, 653, 731, 536, 661, 568, and 563) were associated with the production and storage of TEL and similar products. The majority of buildings in the TEL FA have been dismantled and only some building foundations remain. The only current operating unit in the area is the SET organic stripper. This unit receives off-site waste with high organic content and uses a steam stripper to separate the wastewater from the organic non-aqueous phase liquid. The wastewater is conveyed to the WWTP for treatment, and the non-aqueous liquid is drummed and shipped off-site for disposal. Operation of the organic stripper is performed in accordance with SET procedures and applicable permits.

8.2.6 SWMU 17 and SWMU 56A

Sections of SWMU 17 and SWMU 56A are located within the TEL FA. Details about these SWMUs are presented in Section 4.3.1.

8.3 Pathway Analysis

The following pathway analysis was performed in accordance with the methodology described in Section 3.7.1.

Based on the historical assessments presented above, the Antiknocks area (SWMU 57) is subject to pathway analysis to determine if additional investigation is necessary. This area includes SWMU 6 (Landfill II), C Ditch Process Water Ditch System, TEL process and storage buildings, ethyl chloride AST farm, and railroad loading/unloading area.

This conclusion was based on review of the historical area information, aerial photographs, existing data from various media, previous investigations, and existing remedial documentation. This section provides the information that was collected and discusses the evaluation that was conducted.

This pathway analysis used, to the extent possible, the existing environmental data in accordance with the NJDEP Technical Requirements. Relevant tables are provided in the CD in Appendix D.

- Chemical Process Database: The TEL area was used to produce tetrethyl lead, an anti-knock preventative agent for automobiles. Additionally, TML, TMEL, and sodium-lead alloy were produced in the Antiknocks area. The raw materials, intermediates, products and wastes were reviewed as part of this evaluation.
- Buildings, Trenches, and Utilities Review: The GIS Building layer, Ditches/Trenches/Outfalls layer, and the Utilities layer were reviewed for this focus area.
- Soil Data: Soil analytical data for this focus area are provided in Appendix D. Boring locations are shown in Figure 8-4. Further discussion of relevant data is discussed in the following section.
- Sediment Data: Sediment samples were not collected in the TEL focus area.
- Surface-Water Data: Surface-water samples were not collected in the TEL focus area.
- Groundwater Data: Groundwater data are available for nine active wells located along the eastern perimeter of the focus area. These nine wells have been sampled periodically over time, and a few of the wells are sampled as part of the perimeter monitoring program that is reported in the semi-annual DGW reports. Well locations, total lead concentrations, and groundwater flow are shown in Figure 8-5. Groundwater flow is predominantly to the east, as a result of the IWS; however, a groundwater divide exists near to the boundary with the Delaware River, and shallow groundwater could discharge to the Delaware River.

The primary manufacturing component in the TEL FA was lead, and this compound was most commonly detected in the soil and groundwater samples. Therefore, total lead is used to illustrate the contaminant distribution.

8.3.1 SWMU 57, SWMU 6, C Ditch PWDS, and TEL Process/Storage Buildings

SWMU 57 is the Antiknocks Area, which also includes all historical TEL process and storage buildings. SWMU 6 (Landfill II) is also located within SWMU 57 and is included as part of the discussion for SWMU 57.

Characterization sampling of SWMU 57 and SWMU 6 indicated the primary constituents of concern are inorganic and organic lead compounds. The highest concentrations of lead were found in the subsoil of C Ditch. Elevated lead concentrations have been detected in the areas of both SWMU 57 and SWMU 6. SPLP lead concentrations are also elevated and indicate a potential source of lead in groundwater.

Much of SWMU 57 is covered by building foundations, asphalt, concrete, or crushed stone, thereby minimizing potential exposure to soil. Two areas in the northern portion of the SWMU were either not covered or were covered with fill material. Soil samples were collected in these areas during Phase III RFI, and lead and TEL were detected in the samples above criteria. Air sampling of these areas also was conducted to evaluate potential exposure to workers in the area. Results indicated lead and TEL below detection limits for air sampling. Lead samples were generally collected from shallow depths. DuPont recommended inspection and maintenance of the gravel cover over this area to reduce exposure potential.

The C Ditch PWDS, which consisted of 2,000 feet of open and partially uncovered ditch, was used to carry wastewater generated during the production of motor fuel antiknock compound (MFAC) in the Antiknocks area. The ditch system is present in Figure 8-2. The wastewater was discharged from the ditch into a sump and pumped to the Antiknocks lead pretreatment facility. Process waters contained various lead compounds. Solids from the process waters in the Antiknocks area settled out and accumulated in the ditches. The solids that settled there were remediated from the ditch between 1989 and 1991. Wastewater was pumped to the Antiknocks area lead pretreatment facility for pH adjustment and solids removal. All sludge was removed from the ditch system and also processed through the lead pretreatment facility.

Sampling conducted along the ditch system was conducted to delineate and/or characterize the bottom soils in the ditch. Soil samples were collected from within the boundary of the ditch system and analyzed for total lead and lead compounds including TEL. Soils data indicated concentrations of total lead, TEL, and low concentrations of VOCs. Additional sampling was conducted in the ditch system for analysis of total lead, total organic lead, and select VOCs (chlorobenzene and 1,2-dichlorobenzene). Several samples exceeded the screening level for lead. Total organic lead was also detected in several samples, but VOC concentrations were below screening levels. Shallow ditch samples generally demonstrated the most significant concentrations of lead and total organic lead. It was determined that total lead and total organic lead should be the only analytes for further sampling within the Antiknocks Area.

Based on the results of the Antiknocks area PWDS sampling, DuPont and the NJDEP agreed to excavate all soil beneath the C Ditch that exceeded 10,000 ppm total lead. At the request of NJDEP, pre-excavation samples were collected every 250 linear feet along the ditch. Sampling was conducted to define the vertical extent of total lead concentrations to a depth of 20 feet below grade. Several samples exceeded the screening level for total lead and the results were used to define the limitations of the excavation of the ditch.

Remedial actions completed for the C Ditch system, included the following:

- Performed in-situ stabilization of 41,800 cubic feet of subsoil contained within the C Ditch with total lead concentrations of greater than 10,000 ppm.
- Excavated and placed the treated subsoil into the vault located within the boundaries of the A/B Basin hazardous waste management unit.
- Installed a storm conveyance system to maintain plant drainage.

It was recommended after the initial ditch sampling event, that no further characterization sampling of the PWDS be required because the ditch has been characterized to the groundwater table and concentrations in sidewall samples are similar to those found in the remainder of SWMU 57. Closure has not been obtained for the C Ditch system.

Lead concentrations exceeding NRDCSCC were detected in several soil samples collected in and along the ditches and in areas of former building foundations (see Figure 8-4).

Lead concentrations in groundwater for this FA are shown in Figure 8-5. As shown in the figure, there are insufficient data across most of the FA to define groundwater quality. Collection of groundwater samples downgradient of the former TEL manufacturing area and associated ditch system is recommended to evaluate whether these areas are potential sources of groundwater contamination.

8.3.2 Ethyl Chloride AST Farm and Railroad Loading/Unloading Area

No groundwater data have been collected for the ethyl chloride AST farm (Buildings 661 and 771; Figure 8-4) and the adjacent railroad loading/unloading area that is located in the northern portion of the FA. Therefore, collection of groundwater samples downgradient of these features is recommended to whether these areas are potential sources of groundwater contamination.

8.4 Summary of Recommendations

Based on the pathway analysis, the following is recommended for the TEL FA:

- Collect groundwater samples downgradient of the process wastewater ditches and process building trenches in the eastern side of the FA because there are currently insufficient analytical data to evaluate groundwater quality downgradient of these potential sources.
- Collect groundwater samples in the vicinity of the AST farm to evaluate the potential effects on groundwater quality.

- Collect groundwater samples in the FA interior because there are currently insufficient analytical data to characterize groundwater quality in this area.
- Collect groundwater samples downgradient of the former railroad loading/unloading area to evaluate the potential effects on groundwater quality.
- Measure hydraulic head in aquifer at multiple locations near the FA perimeter to calculate horizontal hydraulic gradient and therefore assess hydraulic containment by the IWS.
- Evaluate sediment quality in the vicinity of the historical process wastewater outfalls along the Delaware River. The sampling will be performed as part of the perimeter investigation.

Groundwater samples may be collected from wells that are currently not used for sampling purposes, where present, or by installing additional monitoring wells, for example. Details about the recommended investigations, such as the number and location of monitoring wells, sampling locations, and sampling methodologies, will be presented in subsequent work plans.

Areas recommended for investigation are shown in Figure 8-6.

9.0 FOCUS AREA – FLUOROPRODUCTS

Assessment of the Fluoroproducts FA indicates that further investigation is warranted throughout the FA. The recommended investigations are based on the evaluation of historical process data, aerial photographs, site maps, analytical results of soil, sediment, and groundwater sampling, and on a pathway analysis. The review and analyses were conducted consistent with applicable regulations and guidelines.

Fluoroproducts such as Freon® were produced in the Kinetic area, and elevated concentrations of compounds typical of raw products and waste stream products, such as trichlorofluormethane, dichlorodifluoromethane, chloroform, carbon tetrachloride, and PCE, are present in monitoring wells. Elevated concentration of these compounds are present in a shallow well that is close to a former trench segment and former outfall, suggesting the ditches may be former or current sources to groundwater. Unlike other areas of the Chamber Works manufacturing area, some of the process wastewater ditches in the Fluoroproducts FA were not remediated. Therefore, these ditches may be sources for groundwater contamination. Collection of groundwater samples is recommended in the vicinity of ditch segments to evaluate groundwater quality and the presence of NAPL and DNAPL. Installation of a monitoring well in the vicinity of the former outfall is also recommended to evaluate the potential for groundwater to surface-water pathways.

Additional monitoring well(s) are recommended for areas downgradient of the ditch network because there is currently an insufficient number of wells to characterize the spatial extent of contaminated groundwater.

Collection of groundwater samples is also recommended in the former petroleum tank area and alcohol area because there are currently no analytical data to characterize groundwater quality.

The Fluoroproducts FA borders the Delaware River. Therefore, sediment sampling in the vicinity of former process wastewater outfalls is recommended in order to evaluate the potential impact of legacy discharges.

The full evaluation is presented in the rest of this section. Details about the recommended investigations, such as number and location of monitoring wells, sampling points, and sampling methodology, will be presented in subsequent work plans.

9.1 Areas of Interest

The Fluoroproducts FA is approximately 52 acres and located in the northwest section of the Chambers Works manufacturing area (see Figure 9-1). This focus area is bounded by the Delaware River to the west, the Basins FA to the north-northeast, and the TEL FA to the southwest and includes Kinetic and Freon Roads.

Based on common processes, history, chemical use, and disposal practices, the Fluoroproducts FA has been subdivided into the following two distinct areas: the former Alcohol Plant and former Kinetic area (see Figure 9-1).

A number of areas or features are pertinent to the Fluoroproducts FA history, as shown in Figure 9-2. These include six SWMUs where significant investigative and/or remedial measures are completed, so there is no need for a potential pathway analysis as part of this PAR. The nine investigated/remediated SWMUs are as follows:

- SWMU 5A: Landfill I
- SWMU 20: Ethyl Chloride Incinerator
- SWMU 26: Freon Spent Catalyst Storage Area
- SWMU 33: Manhattan Project Area
- SWMU 34: Gypsum Disposal Area
- SWMU 35: Freon Disposal Impoundment
- SWMU 39-3: USTs
- SWMU 55-4: Fill Deposition Area
- SWMU 59: Disposal Area V

A summary of previous investigations for these SWMUs is discussed in Section 9.3. These SWMUs have been previously investigated and an evaluation of available data indicates that further evaluation of these areas is not required in the pathway analysis.

Several additional historical features are present within the Alcohol Plant and Kinetic area that are considered areas of interest (Figure 9-3).

9.2 History

The Fluoroproducts FA includes Plant 4, which was established by the DuPont Explosive Department to manufacture picric acid. The first picric acid was produced in 1915 by nitration of phenol and production of dimethylaniline (DMA) for conversion to tetryl. Plant 4 became known as the "High Explosive Plant." The plant was built in the Deepwater Point area, mainly due to the natural fire barriers, proximity to Carneys Point Works (and its transportation and process water supply structures), and room for expansion.

In 1915, two still houses located near the riverfront were installed to extract benzene, toluene, naphtha, and other hydrocarbons from coal-tar. Production of benzene, toluene, xylene, naphthalene, solvent naphtha was increased in 1916 with the addition of a cracking plant. The picric acid manufacturing was augmented in 1917 by a supplementary process and equipment to make ammonium picrate, which was used in American military explosives. Sulfur black dye was also manufactured in the High Explosive Area when the Dye Works first began dye development.

In 1915, the Saltpeter Plant was built near the waterfront about midway between the Explosive Plant and Salem Canal mouth. The plant refined crude nitrate by removing impurities and providing high quality sodium nitrate to the powder plants.

9.2.1 Former Alcohol Plant

The Alcohol Plant was located on the southern side of the Fluoroproducts FA. In the early 1900s, the plant also included storage areas and the sodium sulfide house. The Eastern Alcohol Corporation was formed in 1925 and was jointly owned by DuPont and Kentucky Alcohol Co. (subsidiary of National Distilleries Corporation).

Construction of the Alcohol Plant began in 1925 and operations started a year later. Production during the first five months of operations was nearly 3 million gallons of alcohol. The basic process for manufacturing alcohol was to pump, via pipelines, molasses transported by ship to large storage tanks. The molasses would then be diluted and "cooked" as partial pasteurization. It was then fermented with yeast cultures to produce beer. From beer, the alcohol was distilled. The initial plant included the following buildings: fermenter house, still house, denaturing house, bonded warehouse, drumming building, maintenance shop, change house, office, and six steel tanks each capable of holding over 1 million gallons of molasses.

The by-product of carbon dioxide gas was purchased by Solid Carbonic Co. for making dry ice starting in 1927. Under a land-lease agreement with DuPont, the Solid Carbonic Co. built a plant adjacent to the Alcohol Fermentation building.

In 1931, a new building for the production of butyl alcohol, acetone, and isopropyl alcohol by fermentation was completed. The process was discontinued in 1932. In 1933, the Alcohol Plant started to produce its own antifreeze compound consisting of a blend of alcohol and rust inhibitors called the "Five-Star Anti Freeze". Distribution of the anti-freeze was discontinued in 1948. Alcohol production during WWII ranged from 25.5 to 26.6 million gallons per year.

In 1953, fermentation was discontinued. The following year, one-third of the former Alcohol Plant was leased to Pure Carbonic Division of Air Reduction Corporation, which generated carbon dioxide gas from petroleum combustion.

Based on the 1917 plant layout map, one toluol tank storage area and a series of oil tanks were present in the area near SWMU 33.

9.2.2 Former Kinetic Area

The former Kinetic area is located on the northern side of the Fluoroproducts FA. The former Kinetic area was used for nitrating and sulfur black production as well as Freon production. In 1930, Kinetic Chemicals, Inc., was formed and jointly owned by DuPont and GM for the purpose of manufacturing Freon to be used as refrigerant. Freon research began immediately in 1930 at Jackson Labs at the Dye Works Plant until a continuous process was developed. At least six different Freon refrigerants were manufactured in the Fluoroproducts FA, including Freon-11, Freon-12, Freon-113, Freon-114, Freon-22 (raw product in "Teflon"), and Freon-21.

The basic chemical reaction involves bringing organic material together with hydrofluoric acid (HF) in the presence of a catalyst (i.e., antimony chlorofluoride. Common organics used in the basic chemical reaction include the following:

- Carbon tetrachloride (CCl_4; F-11 and F-12)

- Chloroform ($CHCl_3$; F-21 and F-22)
- Tetrachloroethene (PCE) a.k.a. perchloroethylene (F-113 and F-114)

The first plant built for Freon manufacturing was the Freon Building (K-1) and was located in the northern portion of the focus area. By October 1931, a second manufacturing unit was installed to meet demand. A hydrofluoric acid (HF) plant was built to supply the raw material necessary for Freon production. Other major process changes or historical significant events included the following:

- By late 1932, other Freon products were being manufactured, including "Freon-113" and "Freon-114" with a small amount of "Freon-11" being produced.
- From 1934 to 1935, PCE was substituted for hexachlorethane as the starting material for Freon-114.
- In 1936, the process was changed to improve Freon drying by substituting alumnia gel for the sulfuric acid tower process.
- By 1941, "Freon-21 and "Freon-22" were added to the Kinetic product list.
- In 1942, HCl by-product was recovered (it was previously discharged with trade waste to the ditches).
- In 1944, new plants for "Freon-12" and HF were completed, doubling the capacity of the area.
- During WWII, the demand for Freon increased sharply. A third manufacturing unit was erected in a new building beside the first two units. In the 1950s, Kinetic Chemicals was acquired entirely by DuPont.
- In about 1953, DuPont started to ship Freon in pressurized tank cars and trucks. In conjunction with new shipping procedures, nine 10,000 bulk storage tanks were erected.
- In 1955, DuPont stopped manufacturing zinc silicofluoride and "Freon-22" at the site.
- In 1956, DuPont celebrated the billionth pound of Freon products being produced.
- In 1957, the organization name was changed from the Kinetic area to the Freon area.

A second ethyl chloride plant (Plant 2) was constructed in approximately 1937 and was located adjacent to the Kinetic plant on the site of the old High Explosive Plant buildings. This plant recovered hydrochloric acid that was formerly discharged to the process waste ditch as a waste product from the Freon production in the Kinetic area. Approximately 0.5 million pounds of HCl were condensed from coolers.

Ethyl chloride was made by the aluminum chloride-catalyzed reaction of anhydrous hydrogen chloride (HCl) with ethylene. Waste from this process consisted of waste gas (containing HCl, ethyelene, and ethyl chloride) and liquid waste (contained HCl, aluminum chloride, ethylene chloride, and high boiling organic impurities).

A by-product of the process was 50,000 to 95,000 pounds of salt cake. Most of the salt cake (>60%) was sold. All ethyl chloride production was suspended in 1945 and resumed in 1949. By 1955, all of the ethyl chloride production at the site was being made in the "Kinetic" area.

Various tanks were observed starting in the 1939 plant layout map in the eastern section of the Kinetic area near the site perimeter. The original tanks were for the ethyl chloride operations and the buildings associated with the tanks indicated that nitrating was being completed in this area. Later, more Kinetic buildings and associated tank areas were built in this area. Another tank handling area was present in the northwest corner of the Kinetic area.

9.2.3 Current Operations

Freon production ceased in the early 1980s. Current production in this focus area involves three classes of chemicals: propellants, electronic gases, and refrigerants. Current operations include the manufacturing of three products: HFC-125, HFC-227ea and PFC-116. The compounds HFC-125 and HFC-227ea are produced in the same building, K-39 (FE™ Products), and PFC-116 is produced in Building K-40 (Zyron® Products). Additional products HFC-23, Zyron® 8020, and HFC-236 are purified or transloaded in the area. DuPont Fluoroproducts also produces the following classes of chemicals:

- Electronic gases (Zyron® 116, Zyron® 23, and Zyron® 8020)
- Refrigerants SUVA® 95 and Freon 23
- Fire Extinguishants FE-36™, FE-13™, and FE-227™

The area continues to use hydrofluoric (HF) acid as a basic building block (raw material) in chemical processes. Wastewater is discharged into collection tanks and pumped to the WWTP via overhead pipeline.

9.3 Previous Investigations

The SWMUs identified as part of the RFI within the Fluoroproducts FA include the following:

- SWMU 5A: Landfill I (see Section 12 for details about the SWMU 5 previous investigation)
- SWMU 20: Ethyl Chloride Incinerator
- SWMU 26: Freon Spent Catalyst Storage Area
- SWMU 33: Manhattan Project Area
- SWMU 34: Gypsum Disposal Area
- SWMU 35: Freon Disposal Impoundment
- SWMU 39-3: USTs
- SWMU 55-4: Fill Deposition Area

- SWMU 59: Disposal Area V

More complete descriptions of these SWMUs were previously submitted in January 2002, in the report titled *Chambers Works FACT Sheets* (DuPont, 2002).

9.3.1 SWMU 20 (Ethyl Chloride Incinerator)

SWMU 20 is 2.4 acres and is located in the northern portion of this focus area (see Figure 9-2). The two-unit, ethyl chloride incinerator was used to burn waste products associated with ethyl chloride operation. The incinerator had two water scrubbers in series that prevented particulate release to the air. In addition, 12 emergency interlocks prevented accidental releases. This unit began operation in 1971, operated under interim status in Building 1126, and was monitored under RCRA Part B and NJDEP Air Permit #PC42570/65076/076. The only waste stream that entered SWMU 20 was comprised of ethyl chloride, ethylene, aluminum chloride, hydrochloric acid, and various hydrocarbons The year that operations ceased is unknown. Currently, SWMU 20 is considered clean closed under RCRA according to EPA correspondence. Based on this determination, no further investigation of this SWMU is necessary.

9.3.2 SWMU 26 (Freon Spent Catalyst Storage Area)

SWMU 26 is a storage area that contained a 6,000-gallon lined railroad tank car that was used until 1942 to store spent antimony pentachloride. SWMU 26 is located in the former Kinetic area along Ethyl Chloride Street. DuPont submitted a RCRA closure plan for SWMU 26 in 1984 and investigated this SWMU as part of the Phase III RFI. Closure certification reports were approved by NJDEP, and a postclosure groundwater monitoring program is in effect. The RCRA Unit Post Closure Monitoring Program began for this SWMU in July 2003 in accordance with the NJPDES-DGW permit No. NJ0083429. A downgradient well (G14-M01B) is monitored annually for SWMU-related constituents and reported in the NJPDES-DGW Semiannual Status Report.

9.3.3 SWMU 33 (Manhattan Project Area)

SWMU 33 is located in the southeastern portion of the Fluoroproducts FA and in the northern part of the General Stores area of the Aramids FA (see Figure 9-2). This SWMU is an area that was used by the Manhattan Engineering District (MED) and the Atomic Energy Commission (AEC) from the 1940s through 1960s for radiological activities. SWMU 33 is being investigated as part of the Department of Energy (DOE) FUSRAP program (created to address remaining radiological contamination). The two areas under investigation are located in the Fluoroproducts FA – Former Building 845 Area (including the wooden trough and ditch section that borders the northeast and east portion of this area) and the F Parking Corral (the site of former Building 708). Several radiological surveys, as well as a remediation of B Ditch (SWMU 56A), have been completed for this area.

Beginning in 1942, DuPont entered into an agreement with the U.S. Army Corps of Engineers (AOCE) to conduct manufacturing operations at two locations: the Blue Products area and the East area. The East area is discussed as part of the Miscellaneous

FA (see Section 19). The Blue Products Area was located adjacent to the Alcohol Plant at the southeast border. Beginning in April 1943, the Blue Products operations occupied an idle building known as the Glycerine Building (formerly used by the Alcohol Plant) while four small operating buildings in the area were completed. Production activities in the Blue Products area continued until February 1945. By June 1947, operations in the Blue Products Area had ended, and most of the buildings in the area were rapidly dismantled. By February 1948, dismantlement was complete.

A report was prepared describing the ACOE FUSRAP activities (Roy F. Weston, 2003). Key conclusions from the report are as follows:

- Building 845: Exposure from the residual radiological contamination in the building was substantially below the DOE protection guideline of 100 mrems/year – maximum exposure for DuPont employees was 9 mrem/year, and residual radioactive material remaining in the building did not pose a potential threat of future exposure.
- Parking Lot F: Low-level uranium contamination was detected in the soil.

The ACOE removed nine drums of mixed waste and approximately 40 bags of PPE in 1998. (The PPE was the result of DOE investigation efforts.) In 1999, DuPont completed building demolition. The ACOE investigation of this SWMU is ongoing, and reports describing these investigations are currently being developed by ACOE.

9.3.4 SWMU 34 (Gypsum Disposal Area)

SWMU 34 is 4.3 acres and is located in the western portion of the focus area (see Figure 9-2). This SWMU consists of two areas that were used for the disposal of calcium sulfate (gypsum), a by-product associated with the hydrogen fluoride production process. The SWMU operated prior to 1950 (exact date unknown) to 1962 (due to the installation of the ditch system). The two areas in this SWMU were investigated as part of the Phase II RFI.

Key conclusions in the RFI were as follows:

- No further soil sampling was necessary because all soil sample constituent concentrations were below the NRDCSCC.
- Soil in this SWMU could be a source of groundwater contamination for antimony and lead based on a conservative comparison of SPLP concentrations to GWIIA criteria. This comparison does not account for attenuation and dilution.

Monitoring wells immediately downgradient of SWMU 33 can also be samples for these compounds to assess whether these soils are a source of groundwater contamination.

9.3.5 SWMU 35 (Freon Disposal Impoundment)

SWMU 35 is located near the central portion of this focus area in the former Alcohol Plant area (see Figure 9-2). In May 1993, DuPont requested that the area identified as SWMU 35 be removed from the HSWA permit renewal application (submitted May 7, 1993). In a December 6, 1993, letter to DuPont, the EPA requested further documentation (e.g., personnel interviews, historical information) to support the removal